U.S. Department of Energy
Office of River Protection
P.O. Box 450
Richland, Washington 99352

02-OSR-0290

Mr. Ron F. Naventi, Project Manager
Bechtel National, Inc.
3000 George Washington Way
Richland, Washington 99352

Dear Mr. Naventi:

CONTRACT NO. DE-AC27-01RV14136 – SAFETY EVALUATION REPORT (SER) OF THE HIGH LEVEL WASTE AND LOW ACTIVITY WASTE PARTIAL CONSTRUCTION AUTHORIZATION REQUEST, REVISION 0

References:

1. ORP letter from R. C. Barr to R. F. Naventi, BNI, "Draft Safety Evaluation Report (SER) of the High Level Waste and Low Activity Waste Partial Construction Authorization Request," 02-OSR-0267, dated June 17, 2002.

2. BNI letter from A. R. Veirup to M. K. Barrett, ORP, "Request for Review and Approval of the Partial Construction Authorization Request for the Hanford Tank Waste Treatment and Immobilization Plant," CCN: 024490, dated December 10, 2001.

Enclosed is the U. S. Department of Energy, Office of River Protection, Office of Safety Regulation (OSR) completed SER for the Bechtel National, Inc., Partial Construction Authorization Request submitted in Reference 2. The draft SER was previously provided to BNI, Reference 1, for your review and comment. This SER supports issuance of an authorization agreement for construction of the High Level Waste and Low Activity Waste Building basemats. The SER is being made available to the public, the Defense Nuclear Facilities Safety Board, and local stakeholders.

Please direct any questions to Mr. Lewis F. Miller Jr. of my staff, (509) 376-6817. Nothing in this letter should be construed as changing the Contract, DE-AC27-01RV14136. If, in my capacity as the Safety Regulation Official, I provide any direction that your company believes exceeds my authority or constitutes a change to the contract, you will immediately notify the Contracting Office and request clarification prior to complying with the direction.

Sincerely

Robert C. Barr
Safety Regulation Official
Office of Safety Regulation

OSR:LFM

Enclosure

ORP/OSR-2002-18
Revision 0

SAFETY EVALUATION REPORT FOR WASTE TREATMENT PLANT (WTP) PARTIAL CONSTRUCTION AUTHORIZATION

(Phase I – LAW/HLW Basemat Concrete Placement)

June 25, 2002

Office of Safety Regulation

U.S. Department of Energy
Office of River Protection
P.O. Box 450, H6-60
Richland, Washington 99352

Approved: ___Robert C. Barr____________

Date: ________6/26/02_________________

PREFACE

As directed by Congress in Section 3139 of the *Strom Thurmond National Defense Authorization Act for Fiscal Year 1999,* the U.S. Department of Energy (DOE) established the Office of River Protection (ORP) at the Hanford Site to manage the River Protection Project (RPP), formerly known as the Tank Waste Remediation System. ORP is responsible for the safe storage, retrieval, treatment, and disposal of the high level nuclear waste stored in the 177 underground tanks at Hanford.

The initial concept for treatment and disposal of the high level wastes at Hanford was to use private industry to design, construct, and operate a Waste Treatment Plant (WTP) to process the waste. The concept was for DOE to enter into a fixed-price contract for the Contractor to build and operate a facility to treat the waste according to DOE specifications. In 1996, DOE selected two contractors to begin design of a WTP to accomplish this mission. In 1998, one of the contractors was eliminated, and design of the WTP was continued. However, in May 2000, DOE chose to terminate the privatization contract and seek new bidders under a different contract strategy. In December 2000, a team led by Bechtel National, Inc. was selected to continue design of the WTP and to subsequently build and commission the WTP.

A key element of the River Protection Project Waste Treatment Plant (RPP-WTP) is DOE regulation of safety through a specifically chartered, dedicated Office of Safety Regulation (OSR). The OSR reports directly to the ORP Manager. The regulation by the OSR is authorized by the document entitled *Policy for Radiological, Nuclear, and Process Safety Regulation of the River Protection Project Waste Treatment Plant Contractor* (DOE/RL-96-25) (referred to as the Policy) and implemented through the document entitled *Memorandum of Agreement for the Execution of Radiological, Nuclear, Process Safety Regulation of the RPP-WTP Contractor* (DOE/RL-96-26) (referred to as the MOA). These two documents provide the basis for the safety regulation of the RPP-WTP at Hanford.

The foundation of both the Policy and the MOA is that the mission of removal and immobilization of the existing large quantities of tank waste by the RPP-WTP Contractor must be accomplished safely, effectively, and efficiently.

The Policy maintains the essential elements of the regulatory program established by DOE in 1996 for the privatization contracts. The MOA clarifies the DOE organizational relationships and responsibilities for safety regulation of the RPP-WTP. The MOA provides a basis for key DOE officials to commit to teamwork in implementing the policy and achieve adequate safety of RPP-WTP activities.

The Policy, the MOA, the RPP-WTP Contract and the four documents incorporated in the Contract define the essential elements of the regulatory program being executed by the OSR. The four documents incorporated into the Contract (and also in the MOA) are as follows:

> *Concept of the DOE Process for Radiological, Nuclear, and Process Safety Regulation of the RPP Waste Treatment Plant Contractor,* DOE-96-0005,
>
> *DOE Process for Radiological, Nuclear, and Process Safety Regulation of the RPP Waste Treatment Plant Contractor,* DOE/RL-96-0003,
>
> *Top-Level Radiological, Nuclear, and Process Safety Standards and Principles for the RPP Waste Treatment Plant Contractor,* DOE/RL-96-0006, and
>
> *Process for Establishing a Set of Radiological, Nuclear, and Process Safety Standards and Requirements for the RPP Waste Treatment Plant Contractor,* DOE/RL-96-0004.

DOE patterned its safety regulation of the RPP-WTP Contractor to be consistent with the concepts and principles of good regulation (stability, clarity, openness, efficiency, and independence) used by the Nuclear Regulatory Commission (NRC). In addition, the DOE principles of integrated safety management were built into the regulatory program for design, construction, operation, and deactivation of the facility. The regulatory program for nuclear safety permits waste treatment services to occur on a timely, predictable, and stable basis, with attention to safety consistent with that which would occur from safety regulation by an external agency. DOE established OSR as a dedicated regulatory organization to be a single point of DOE contact for nuclear safety oversight and approvals for the WTP Contractor. The OSR performs nuclear safety review, approval, inspection, and verification activities for ORP using the NRC principles of good regulation while defining how the Contractor shall implement the principles of standards-based integrated safety management.

A key feature of this regulatory process is its definition of how the standards-based integrated safety management principles are implemented to develop a necessary and sufficient set of standards and requirements for the design, construction, operation, and deactivation of the RPP-WTP facility. This process closely parallels the DOE necessary and sufficient closure process (subsequently renamed Work Smart Standards process) in DOE Policy 450.3, *Authority for the Use of the Necessary and Sufficient Process for Standards-based Environment, Safety and Health Management*, and is intended to be a DOE approved process under DOE Acquisition Regulations, DEAR 970.5204-78, *Laws, Regulations and DOE Orders,* Section (c). DOE approval of the contractor-derived standards is assigned to the OSR.

The RPP-WTP Contractor has direct responsibility for WTP safety. DOE requires the Contractor to integrate safety into work planning and execution. This integrated safety management process emphasizes that the Contractor's direct responsibility for ensuring that safety is an integral part of mission accomplishment. DOE, through its safety regulation and management program, verifies that the Contractor achieves adequate safety by complying with approved safety requirements.

All documents issued by the Office of Safety Regulation are available to the public through the DOE Public Reading Room at the Consolidated Information Center, Washington State University, Room 101L, Richland, Washington. Copies may be purchased for a duplication fee.

RECORD OF REVISION

Document Title: Safety Evaluation Report for Waste Treatment Plant (WTP) Partial Construction Authorization

Document Number: ORP/OSR-2002-18

Revision Date	Revision Number	Reason for Revision
06/25/02	0	New Issue

EXECUTIVE SUMMARY

This report summarizes the safety evaluation performed on the first segment of the Construction Authorization Request (CAR) submitted by Bechtel National, Inc. (BNI), to the Office of Safety Regulation (OSR) within U.S. Department of Energy's Office of River Protection (ORP). This safety evaluation report covers the review and approval of the following two BNI submittals:

- Partial Construction Authorization Request (PCAR), dated December 10, 2001, for the low-activity waste (LAW) facility. This request covers installing forms, rebar, and embedments (FRE) for the basemat; installing the ground grid connection to the basemat rebar; and placing the LAW basemat concrete.[1]

- PCAR for the high-level waste (HLW) facility, dated December 10, 2001. This request covers installing FRE for the basemat, installing the ground grid connection to the basemat rebar, and placing the HLW basemat concrete.

Based on the safety evaluation described in this document, the OSR recommends authorization of the construction of the basemats for the LAW and HLW facilities, subject to the conditions below (by section).

Section 3.7 Radiation Protection

Conditions of Acceptance – BNI must include the following provisions in the Radiological Controls Program. Except for Item 2 below, these provisions must be provided with the Final Safety Analysis Report (FSAR):

1. A detailed organizational chart that shows the radiation safety organization and its relationship to senior plant personnel and other line managers. Also, provide job descriptions defining specific authorities and responsibilities of radiation safety personnel.

2. Specify the review and revision cycle of procedures and provide to DOE before the start of the pre-operational testing phase.

3. Describe the mechanism for ensuring that Radiation Work Permits are not used past their termination dates.

4. Describe the methods for analyzing airborne concentrations; methods for calibrating air sampling and counting equipment; actions levels and alarm setpoints; the basis used to determine action levels, investigation levels, and derived air concentrations and minimum

[1] Subsequent to this request, on February 28, 2002, BNI requested authorization to install basemat forms, rebar, and embedments before completing this safety analysis, using the provision of 10 CFR 830.206(b), "Preliminary documented safety analysis." The Office of Safety Regulation approved this request on March 7, 2002.

detectable activities for the radionuclides; the frequency and methods for analyzing airborne concentrations; counting techniques; specific calculations and levels; action levels and investigation levels; locations of continuous air monitors, if used; and locations of annunciators and alarms.

5. Identify the types and quantities of contamination monitoring equipment and the methods and types of instruments used in the surveys.

6. Identify the locations of the facility's respiratory equipment.

7. Describe the radiation measurement selection criteria for performing radiation and contamination surveys, sampling airborne radioactivity, monitoring area radiation, and performing radioactive analyses. List the types and quantities of instruments that are available, as well as their ranges, counting mode, sensitivity, alarm setpoints, and planned use. Describe the instrument storage, calibration, and maintenance facilities and laboratory facilities used for radiological analyses in the FSAR.

Section 3.12 Procedures and Training

Procedures

Conditions of Acceptance – BNI must complete the following changes to Section 12.3 of Volume I of the PCAR with the first revision of the Preliminary Safety Analysis Report (PSAR) after authorization for construction:

1. Revise Section 12.3.1.1 to state that, "The project readiness assessment process determines the procedure set required to support Construction activities. Procedures are developed and issued before the activity governed by the procedure takes place." In addition, provide a table in Section 12.3.1.1 to indicate which activities are being addressed in management control procedures during design and construction, cold commissioning, and hot commissioning and operations.

2. Revise Section 12.3.2.2 to state, "The procedures covering the following topics are in place as needed for the construction phase of the project. Changes and additions to the procedure set will be identified before cold commissioning and scheduled for completion before the activity taking place: major management control systems, system and facility operations (including control of hazardous processes), major maintenance activities (including safe work practices), hazardous materials control activities, radiological control activities, and emergency response activities (including radiological and hazardous chemical release)."

3. Revise Section 12.3.1.1 as follows to clarify who can approve procedures: "The procedure process is governed by the project procedure on procedures. It requires that management associated with environment, safety, and health (ES&H) and quality assurance (QA) review new procedures and concur that they are or are not within the authorization basis. ES&H and QA review changes to existing procedures if they affect

the authorization basis or QA requirements. At a minimum, management associated with the relevant safety disciplines concurs with new procedures and changes to existing procedures that affect the authorization basis requirements."

4. Add the following to Sections 12.3.3.1 and 12.3.3.2.1: "The project procedure complies with the Waste Treatment Plant Quality Assurance Manual and addresses permanent procedure revisions and expedited procedure changes."

5. Add the following to Section 12.3.1.1: "For construction activities, the basic work planning process is based on the concept that for standard construction tasks, step-by-step work instructions are not required. A combination of technical specifications, field procedures, and drawings are used to perform the work. Individuals involved in the work are trained to the requirements. The work is planned using a construction administrative procedure addressing construction work packages. When unique or complex tasks are performed, work planning is addressed in a construction administrative procedure addressing special instruction work packages. This procedure provides for using a work package with additional controls, including, where appropriate, step-by-step instructions."

Training

Conditions of Acceptance – BNI must complete the following changes to Section 12.4 of Volume I of the PCAR with the first revision of the PSAR after authorization for construction:

1. Define the periodic basis for comparing training materials with the list of tasks selected for training.

2. Clearly state in the learning objectives the knowledge, skills, and abilities the trainee must demonstrate; that learning objectives are sequenced based on their relationship to one another; the conditions under which required actions will take place; and the standards of performance the trainee should achieve when completing the training.

3. Define review and approval requirements for lesson plans, training guides, and other training materials before they are issued and used.

4. Describe that when an actual task cannot be performed and is walked-through, the conditions of task performance, references, tools, and equipment reflect the actual task to the extent possible.

5. Define the periodic basis for conducting training program evaluations.

Section 3.16 Deactivation and Decommissioning

Conditions of Acceptance – BNI must complete the following changes to Chapter 16 of Volume I of the PCAR, or to the draft deactivation plan, with the first revision of the PSAR after authorization for construction:

1. In Chapter 16 or in the draft deactivation plan, clarify its commitment to reduce radiation exposure to workers and the public during and following deactivation and decommissioning.

2. Add the following statement to Section 16.3.5: "While the proposed decommissioning method has not been specified, the facility is being designed to limit contamination, facilitate decontamination, and minimize the dose and generation of waste in the event reuse or demolition of the facility is the ultimate decommissioning method."

3. Change the R1, R2, and R3 contamination classifications listed in Section 16.3.1 consistent with current procedures, i.e., C1, C2, C3, and C5 classification.

Section 3.17 Management, Organization, and Institutional Safety Provisions

Conditions of Acceptance – BNI must complete the following actions by the date or milestone indicated:

1. Describe organizational responsibilities and staffing interfaces for the configuration management program in Section 17.4.3 of Volume I of the PCAR with the first revision of the PSAR after authorization for construction.

2. Revise procedure 24590-WTP-GPP-SIND-001-0, *Reporting Occurrences in Accordance with DOE Order 232.1A*, to address hazards and activities before the start of pre-operational testing phase.

Section 4.1.2 LAW Facility Hazard and Accident Analysis

Conditions of Acceptance – BNI must complete the following actions by the date or milestone indicated:

1. Correct the discrepancies related to the control strategy development records identification system used in Standards Identification Process Database and as referenced in the LAW PCAR and HLW PCAR texts and tables with the first revision of the PSAR after authorization for construction.

2. Revise the design calculation report 24590-LAW-DBC-S13T-00005, *Thermal Analysis for Basemat and Pour Cave Walls*, to incorporate the results of the computational fluid dynamics analysis of the pour cave. The analysis must confirm that the concrete temperatures of the melter and pour caves could be maintained within design limits during the postulated loss of cooling accident scenario. All structural calculations affected by the computational fluid dynamics analysis must be revised, as appropriate. These should be completed before authorization of LAW facility construction.

3. Revise the PSAR to correct the omission of an additional safety function for the basemat based on the seismic DBE event being SL-2 for the facility and co-located worker, the

mis-feed event being SL-1 for the facility worker, and the liquid spill/overflow from the LAW concentrate receipt vessel being SL-2 for the facility worker. This revision must be done with the first revision of the PSAR after authorization for construction.

Section 4.2.1 HLW Facility Description

Process Description

Conditions of Acceptance – BNI must complete the following action by the date or milestone indicated:

1. Revise the design drawings that were used to support the hazard and accidental analysis of the embedded C5 ventilation ductwork to reflect the configuration used in the accident analysis with the first revision of the PSAR after authorization for construction.

2. Perform transient computational fluid dynamics analysis of the design basis event 2700 L HLW molten glass spill before authorization of HLW facility construction.

Section 4.2.2 HLW Facility Hazard and Accident Analysis

Conditions of Acceptance – BNI must complete the following actions and provide to DOE before authorization by the date or milestone indicated:

1. Provide the DBE analysis of the 2700 L HLW molten glass spill accident before authorization of HLW facility construction.

2. Submit an evaluation of the combined effects of seismically induced radiological releases from the PT, LAW, and HLW buildings on the workers, co-located workers, and the public through a seismic probabilistic risk analysis study, before authorization of full facility construction (not including the Analytical Laboratory).

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Table of Contents

List of Appendixes

List of Tables

SAFETY EVALUATION REPORT FOR WASTE TREATMENT PLANT (WTP) PARTIAL CONSTRUCTION AUTHORIZATION
(Phase I – LAW/HLW Basemat Concrete Placement)

1.0 INTRODUCTION

This document summarizes the safety evaluation performed by the U.S. Department of Energy (DOE), Office of River Protection (ORP), Office of Safety Regulation (OSR), of the River Protection Project-Waste Treatment Plant (RPP-WTP) Contractor's Construction Authorization Requests (CARs). Standard 7, Section e(2)(x) of the RPP-WTP Contract,[2] permits the Contractor [Bechtel National, Inc. (BNI)] to segment and incrementally submit an authorization request associated with a particular regulatory action, such as construction authorization. BNI proposed that construction authorization be done sequentially, as shown in Table 1.

Table 1. BNI Proposals for Sequential Submittal and Approval of CAR Segments

Submittal	Content	Date Submitted to OSR	Date Approved by OSR
Low-Activity Waste Partial Construction Authorization Request (LAW-PCAR)	Installation of forms, rebar, and embedments (FRE) for LAW basemat, connection of the grounding grid, and placement of basemat concrete	11/13/01 Resubmitted 12/10/01	
High-Level Waste Partial Construction Authorization Request (HLW-PCAR)	Installation of FRE for HLW basemat, connection of the grounding grid, and placement of basemat concrete	12/10/01	
LAW CAR and Preliminary Safety Analysis Report (LAW-PSAR)	Construction of full LAW facility	01/31/02	
HLW CAR and Preliminary Safety Analysis Report (HLW-PSAR)	Construction of full HLW facility	02/19/02	
Pretreatment CAR and Preliminary Safety Analysis Report (PT-PSAR)	Construction of full PT facility	05/01/02	
Balance of Facility (BOF) CARs and Preliminary Safety Analysis Reports (BOF-PSAR)	Construction of BOF (support facilities). This will come in four separate parts.	BOF-1 02/19/02 BOF-2 05/01/02 BOF-3 to be determined BOF-4 to be determined	
Analytical Laboratory Construction Authorization Request and Preliminary Safety Analysis Report (Analytical Laboratory PSAR)	Construction of Analytical Laboratory	Not yet Submitted	

[2] Contract No. DE-AC27-01RV14136 between DOE and BNI, dated December 11, 2000.

A structured process was used to review each segment of the construction authorization based on review guidance the OSR prepared before BNI submitted its CAR. The OSR published the review guidance, RL/REG-99-05, *Review Guidance for the Construction Authorization Request (CAR)*, for its reviewers to use in evaluating the CAR.[3] The format and content of RL/REG-99-05 were derived from the U.S. Nuclear Regulatory Commission's (NRC's) Regulatory Guide 3.52, *Standard Format and Content for the Health and Safety Sections of License Applications for Fuel Cycle Facilities*; from NUREG-1520, *Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility*; and from BNI's Integrated Safety Management Plan (ISMP), Section 4.2.3.1, "Safety Analysis Reports."

After RL/REG-99-05 was published, BNI proposed in November 2001 that DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports,* be used for the format and content of its safety analysis reports.[4] The OSR approved the use of DOE/STD-3009-94 only for the *format* of the safety analysis reports. The content[5] of the safety analysis reports was to remain the same as described in NRC's draft Regulatory Guide 3.52, as previously agreed to by OSR and BNI. When BNI requested a change in format and content, the OSR determined that insufficient time existed before submittal of the first PCAR to rewrite RL/REG-99-05 to make the change because its development had taken nearly two years.

On June 29, 2001, BNI notified DOE of its intent to submit to the OSR a PCAR for the RPP-WTP.[6] The PCAR would request authorization for installing FRE for the HLW and LAW facility basemats. The reviewers agreed that BNI could segment and incrementally submit a CAR.[7] BNI subsequently modified the original submittal dates to accommodate changes to the HLW and PT facility designs.[8, 9] The requested approval date for installing FRE for both the LAW and HLW basemats was changed to April 10, 2002, with concrete placement of the basemat for both facilities being July 1, 2002. On March 7, 2002, DOE agreed to permit FRE installation for the WTP before the PSAR safety review was completed.[10]

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3 While the OSR provided guidance, alternative descriptions also were acceptable if they were adequately justified.

4 CCN: 023770, letter, A.R. Veirup, BNI, to M.K. Barrett, ORP, "Contract No. DE-AC27-01RV14136 – "Transmittal for Approval – Authorization Basis Change Notice ABCN-24590-01-00004, Revision 1, Identification of Safety Analysis Report Format and Content," dated November 2, 2001.

5 01-OSR-0483, letter, R.J. Barr, OSR, to R.F. Naventi, BNI, "Contract No. DE-AC-01RV14136 – Partial Approval of Bechtel National Inc. (BNI) Authorization Basis Change Notice, ABCN-24590-01-00004, Rev 1," dated December 5, 2001.

6 CCN: 021118, letter, A.R. Veirup, BNI, to M.K. Barrett, ORP, "Intent to Submit Partial Construction Authorization Request for the River Protection Project Waste Treatment Plant and Request for Contract Change to Support Proposed Target Schedule," dated June 29, 2001.

7 01-OSR-0295, letter, H.L. Boston, ORP, to R. Naventi, BNI, "Contract No. DE-AC27-01RV14136 – Response to Request for Contract Change to Support Proposed Target Schedule and Notification of Intent to Submit Partial Construction Authorization Request," dated August 8, 2001.

8 CCN: 023251, letter, A.R. Veirup, BNI, to M.K. Barrett, ORP, "Contract No. DE-AC27-01RV14136 – Changes to Partial Construction Authorization Request (PCAR) Submittal and Requested Authorization Dates," dated October 16, 2001.

9 CCN: 024681, letter, A.R. Veirup, BNI, to M.K. Barrett, ORP, "Contract No. DE-AC27-01RV14136 – Changes to Partial Construction Authorization Request (PCAR) Submittal Dates," dated November 6, 2001.

10 02-OSR-0075, letter, H.L. Boston, ORP, to R.F. Naventi, BNL, "Contract No. DE-AC-01RV14136 – Proposed Rescheduling of the submittal date for the Pretreatment Building Partial Construction Authorization Request," dated March 7, 2002.

On January 10, 2001, DOE published the revised 10 CFR 830, "Nuclear Safety Management." This rule, in 10 CFR 830.206(b), "Preliminary documented safety analysis," and Subpart B, "Safety Basis Requirements," established specific requirements for establishing and maintaining the safety basis of new DOE nuclear facilities, including the WTP. DOE O 420.1, *Facility Safety*, was identified as an approved source of design criteria for the facility preliminary documented safety analysis.

Subsequent to implementing the revised 10 CFR 830, the OSR verified that the review guidance found in RL/REG-99-05 was generally consistent with these requirements, specifically with the requirements of 10 CFR 830.206(b), insofar as the basemat design criteria. The details of this verification are in ORP/OSR-2001-06, *Office of Safety Regulation Position on Applying Project-Specific Alternative Safety Analysis Methodology in Lieu of the DOE-STD-3009 Safety Analysis Methodology for the RPP-WTP*. This comparison identified several exceptions where inconsistencies existed. On April 15, 2002, the OSR requested BNI to submit an authorization basis change request to correct these deficiencies.[11] The reviewers verified that none of the exceptions were relevant to the safety evaluation of the basemat and that all applicable DOE O 420.1 criteria relevant to the basemat had been incorporated into RL/REG 99-05 review guidance.

1.1 LAW PCAR Submittal

BNI submitted its LAW PCAR to the OSR on November 13, 2001.[12] BNI proposed the following activities for the LAW facility during partial construction: (1) installing FRE for the basemat; (2) installing the ground grid connection to basemat rebar; (3) placing LAW basemat concrete, and (4) placing associated backfill.

The submittal consisted of the following two documents:

- 24590-WTP-PSAR-ESH-01-001-01, *Preliminary Safety Analysis Report to Support LAW Partial Construction Authorization; General Information*

- 24590-WTP-PSAR-ESH-01-001-03, *Preliminary Safety Analysis Report to Support Partial Construction Authorization; LAW Facility Specific Information*.

The OSR performed an acceptability review on both documents and notified BNI on November 21, 2001,[13] that the submittal was rejected for detailed review because the documents

[11] 02-OSR-0152, letter, R. C. Barr, OSR to R. F. Naventi, BNI, "Contract No. DE-AC27-01RV14136-Office of Safety Regulation (OSR) Application of DOE Order 420.1 Requirements to the River Protection Project Waste Treatment Plant (RPP-WTP," dated April 15, 2002.
[12] CCN: 023767, letter, A.R. Veirup, BNI, to M.K. Barrett, ORP, "Contract No. DE-AC27-01RV14136 – Request for Review and Approval of the Partial Construction Authorization Request for the River Protection Project - Waste Treatment Plant," dated November 12, 2001.
[13] 01-OSR-0512, letter, R.C. Barr, OSR, to R.F. Naventi, BNI, "Contract No. DE-AC27-01RV14136 – Acceptability Review for the Low Activity Waste Partial Construction Authorization Request, and Response to Request for Change in Phased Construction Authorization Request," dated November 21, 2001.

provided insufficient detailed information concerning the design and hazard evaluations of the LAW building basemat. BNI resubmitted the LAW PCAR on December 10, 2001,[14] and the OSR accepted the resubmitted documents for detailed review on December 18, 2001.[15]

The OSR reviewed and evaluated both resubmitted documents against all relevant portions of the approval criteria outlined in RL/REG-99-05. The review team's evaluation, conclusions, and recommendations to the Safety Regulation Official for the LAW Partial Construction Authorization (PCA) are presented in Sections 3 and 4 of this safety evaluation report (SER).

1.2 HLW PCAR Submittal

BNI submitted its HLW PCAR to DOE on December 10, 2001.[16] BNI proposed the following activities for the HLW facility during partial construction: (1) installing FRE for the basemat, (2) installing the ground grid connection to basemat rebar, (3) placing HLW basemat concrete, and (4) placing associated backfill. The submittal consisted of the following document:

- 24590-WTP-PSAR-ESH-01-001-04, *Preliminary Safety Analysis Report to Support Partial Construction Authorization; HLW Facility Specific Information*.

The OSR performed an acceptability review on the HLW PCAR and notified BNI on December 18, 2001,[17] that the submittal was acceptable for detailed review. The OSR reviewed and evaluated the HLW PCAR against all relevant portions of the approval criteria outlined in RL/REG-99-05. The review team's evaluation, conclusions, and recommendations to the Safety Regulation Official for the HLW PCA are presented in Sections 3 and 4 of this SER.

2.0 REVIEW PROCESS

This section describes the OSR's process for reviewing the various BNI CAR submittals using the approval criteria outlined in RL/REG-99-05. The LAW and HLW PCARs were reviewed before BNI submitted the LAW and HLW PSARs to enable an earlier start for partial construction while providing the project with opportunities to reduce scheduling risks. The review provided assurance that the proposed partial construction activities would provide for

[14] CCN: 024490, letter, A.R. Veirup, BNI, to M.K. Barrett, ORP, "Contract No. DE-AC27-01RV14136 – Request for Review and Approval of the Partial Construction Authorization Request for the Hanford Tank Waste Treatment and Immobilization Plant," dated December 10, 2001.
[15] 01-OSR-0512, letter, R.C. Barr, OSR, to R.F. Naventi, BNI, "Contract No. DE-AC27-01RV14136 – Approval of the Partial Construction Authorization Request for the Hanford Tank Waste Treatment and Immobilization Plant," dated December 18, 2001.
[16] CCN: 024490, letter, A.R. Veirup, BNI, to M.K. Barrett, ORP, "Contract No. DE-AC27-01RV14136 – Request for Review and Approval of the Partial Construction Authorization Request for the Hanford Tank Waste Treatment and Immobilization Plant," dated December 10, 2001.
[17] 01-OSR-0512, letter, R.C. Barr, OSR, to R.F. Naventi, BNI, "Contract No. DE-AC27-01RV14136 – Approval of the Partial Construction Authorization Request for the Hanford Tank Waste Treatment and Immobilization Plant," dated December 18, 2001.

adequate safety of the workers and the public by (1) applying the integrated safety management (ISM) process, which includes following the contractually prescribed process for requirements' and standards' identification and selection; (2) complying with applicable laws and regulations; and (3) conforming to DOE-stipulated top-level safety standards and principles. In addition, the review confirmed that the criteria of DOE O 420.1, applicable to the basemat design, had been applied as required by 10 CFR 830.206(b).

2.1 PCAR Review Approach

The reviewers evaluated the submittal against the approval criteria listed in all relevant portions of RL/REG-99-05. The review consisted of (1) a one-week acceptability review to determine if the submittal was acceptable for detailed review and (2) the detailed review.

For the ORP Manager to authorize construction of the LAW and HLW basemats, the reviewers determined whether the following criteria were met:[18]

- The proposed important-to-safety (ITS)[19] features were being implemented according to the approved Safety Requirements Document (SRD).
- Proposed changes to the SRD and the ISMP were acceptable.
- The design complied with the design-related sections of the updated SRD.
- The design properly accounted for the natural and manmade external events associated with the designated site.
- BNI was qualified by reason of experience and training to perform the proposed construction.

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[18] DOE/RL-96-0003, *DOE Process for Radiological, Nuclear, and Process Safety Authorization, Verification, and Confirmation of the RPP Waste Treatment Plant Contractor*, Section 3.3.3, "Authorization for Construction."

[19] Important-to-safety refers to structures, systems, and components that reasonably ensure that the facility can be operated without undue risk to the health and safety of the workers and the public. It encompasses the broad class of facility features addressed (not necessarily explicitly) in the top-level radiological, nuclear, and process safety standards and principles that contribute to the safe operation and protection of workers and the public during all phases and aspects of facility operations (i.e., normal operation as well as accident mitigation). This definition includes not only structures, systems, and components that perform safety functions and traditionally have been classified as safety class, safety-related or safety grade but also those that place frequent demands on or adversely affect the performance of safety functions if they fail or malfunction, i.e., support systems, subsystems, or components. Thus, these latter structures, systems, and components would be subject to applicable top-level radiological, nuclear, and process safety standards and principles to a degree commensurate with their contribution to risk. In applying this definition, it is recognized that during the early stages of the design effort all significant systems interactions may not be identified and only the traditional interpretation of important-to-safety, i.e., safety-related may be practical. However, as the design matures and results from risk assessments identify vulnerabilities resulting from non-safety-related equipment, additional structures, systems, and components should be considered for inclusion within this definition.

- The construction procedures were adequate to ensure that the construction-related part of the SRD would be properly implemented.

- The quality assurance (QA) plan was adequate and had been implemented such that the intended quality would be ensured in the ITS portions of construction and that the QA records would attest to that assurance.

- BNI had committed to comply with the conditions of the authorization agreement associated with the PCA.

For the detailed review, the OSR performed the following activities:

- Completed the review according to relevant portions of the guidance document (RL/REG-99-05)

- Prepared and maintained a public record file that contained the information that formed the basis for the review findings and that included correspondence pertinent to the basis for the review findings

- Requested additional information from BNI through formally submitted questions to clarify the submittal[20, 21, 22, 23]

- Prepared a draft SER

- Issued the final SER.

Table 2 lists the relevant portions of the review guidance (RL/REG-99-05) that were used to review the LAW and HLW PCAR submittals. The information addressed during the review consisted of Volume I of the PCAR (i.e., general information on the PCAR scope generic to all of the BNI facilities), Volume III of the PCAR (i.e., specific information on the LAW facility for the PCAR), Volume IV of the PCAR (i.e., specific information on the HLW facility), and the written responses received from BNI to specific OSR questions.

The relevant portions of the review guidance were selected based on the limited scope of the partial construction activities proposed by BNI. Criteria in the guidance document that were not used to review the LAW and HLW PCAR submittals were subsequently used to review the full

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[20] 01-OSR-0513, letter, R.C. Barr, OSR, to R.F. Naventi, BNI, "Office of Safety Regulation (OSR) Questions on the Low Activity Waste Partial Construction Authorization Request," dated December 19, 2001.
[21] 02-OSR-0004, letter, R.C. Barr, OSR, to R.F. Naventi, BNI, "Contract No. DE-AC27-01RV14136 – Second Set of Questions on the Low Activity Waste Partial Construction Authorization Request," dated January 11, 2002.
[22] 02-OSR-0003, letter, R.C. Barr, OSR, to R.F. Naventi, BNI, "Contract No. DE-AC27-01RV14136 – Questions on the High Level Waste Partial Construction Authorization Request," dated January 17, 2002.
[23] 02-OSR-0024, letter, R.C. Barr, OSR, to R.F. Naventi, BNI, "Contract No. DE-AC27-01RV14136 – Second Set of Questions on the High Level Waste Partial Construction Authorization Request and Third Set of Questions on the Low Activity Waste Partial Construction Authorization Request," dated January 25, 2002.

LAW and HLW CAR submittals when BNI submitted them on January 31, 2002, and on February 19, 2002, respectively. (While the LAW and HLW CAR submittals have been received from BNI and are in review, they are not the subject of this SER.)

Table 2. Review Criteria used for LAW and HLW PCAR Reviews

Volume I: General Information	**Review Guidance Section (RL/REG-99-05)**
1. Site Characteristics	1.1 Site Description
2. Facility Description	1.2 Facility Description 1.3 Process Description
3. Hazard and Accident Analysis	4.0 Preliminary Safety Analysis
4. Important-to-Safety Systems, Structures, and Components	4.5.3.3.3 Regulatory Acceptance Criteria
7. Radiation Protection	5.0 Radiological Controls
12. Procedures and Training	3.4 Training and Qualification 3.9 Procedures
14. Quality Assurance	3.3 Quality Assurance
16. Provisions for Deactivation and Decommissioning	11.0 Deactivation and Decommissioning
17. Management, Organization, and Institutional Safety	2.0 Organization and Administration 3.1 Configuration Management 3.6 Audits and Assessments 3.7 Incident Investigations 3.8 Records Management
Volume III: LAW Facility Specific Information	**Review Guidance Section (RL/REG-99-05)**
1. Facility Description	1.2 Facility Description 1.3 Process Description
2. Hazard and Accident Analysis	4.0 Preliminary Safety Analysis
3. Important-to-Safety Systems, Structures, and Components	4.5.3.3.3 Regulatory Acceptance Criteria
Volume IV: HLW Facility Specific Information	**Review Guidance Section (RL/REG-99-05)**
1. Facility Description	1.2 Facility Description 1.3 Process Description
2. Hazard and Accident Analysis	4.0 Preliminary Safety Analysis
3. Important-to-Safety Systems, Structures, and Components	4.5.3.3.3 Regulatory Acceptance Criteria

2.2 Team Composition and Expertise

The OSR used internal and external experts to review the safety documentation submitted by BNI. Appendix A lists the reviewers that were involved in reviewing the LAW and HLW PCARs.

3.0 EVALUATION – GENERAL INFORMATION

This section describes the review that was performed on Volume I of the submittal, *Preliminary Safety Analysis Report to Support Partial Construction Authorization; General Information*. The format for the submittal was based on DOE/STD-3009-94, dated January 2000. The general information volume, when complete, will contain 18 sections, 9 of which were addressed by BNI in the LAW PCAR submittal. The OSR's evaluation of the 9 sections is summarized below and forms the basis for the OSR to approve or disapprove this portion of the submittal. The remaining 9 sections will be reviewed with the submittal of the LAW and HLW segments of the CAR. The conditions of acceptance for the general information evaluation are contained in the text and in Appendix B.

3.1 Site Characteristics

The purpose of this review was to determine whether the submittal adequately described the geographical, demographical, meteorological, hydrological, geological, and seismicity characteristics of the site and the surrounding area. The site description must also be consistent with the site information presented in the most recent environmental impact statement (EIS)[24] and the relevant supplemental analyses for the RPP. This review was specific to the submittal, Volume I, *General Information*, of the LAW PCAR as it related to site characteristics.

3.1.1 Requirements

The site description submittal was acceptable if it was presented at a level of detail appropriate to support the preliminary safety analysis (for the complete RPP-WTP) and if the criteria outlined below were met to support complete hazard analyses:

1. The site geography was described, including the location relative to prominent natural and manmade features such as mountains, rivers, airports, population centers, schools, and commercial and manufacturing facilities.

2. Population information was provided based on the most currently available census data to show distances to nearby population centers.

3. Appropriate meteorological data were included, such as design basis values for accident analysis of maximum snow or ice load; probable maximum precipitation; and the type, frequency, and magnitude of severe weather.

4. The area's hydrology was described, including the characteristics of nearby bodies of water, groundwater flow, and the design basis flood and precipitation events. The flood

[24] *Tank Waste Remediation System, Hanford Site, Richland, Washington Environmental Impact Statement,* August 1996.

was at least a 100-year flood for the site and was consistent with U.S. Army Corps of Engineers' flood plain maps.

5. The geology of the area was described, including the soil characteristics of the site and any geological hazards.

6. The seismicity of the area and the hazard curves derived from them were described. The description included the characteristics of all seismic sources in the region of the site, such as magnitudes and frequency of recurrence of earthquakes, the travel path between the source and the site, and the attenuation effect of the geological materials in the travel path. All of the information provided was used to generate the site-specific seismic hazard curve and the response spectra.

7. Information was provided on the natural phenomena and manmade external events and the rationale for their selection, and nearby facilities and transportation were described. The discussion included which events were considered incredible and the justification for that determination.

8. The descriptions agreed with the site information contained in the most recent EIS and any relevant supplemental analyses for the RPP and with BNI's draft Emergency Response Plan.

3.1.2 Evaluation

The reviewers found the description of site characteristics in Volume I of the LAW PCAR to be acceptable. All eight acceptance criteria listed above were met. The evaluation of the information for each review criterion is summarized below:

1. The reviewers found the description of site geography to be acceptable. The site location relative to prominent natural and manmade features such as mountains, rivers, airports, population centers, schools, and commercial and manufacturing facilities was clearly identified.

2. The reviewers found the population information near the site location to be acceptable. The population information was based on the most currently available census data.

3. The reviewers found the descriptions of meteorology, hydrology, and geology of the facility site and surroundings area to be acceptable. The reviewers also found the information on the design basis for wind, snow, and flood to be acceptable. The submittal also included the following information for the site: the maximum peak gusts, annual probability of wind distribution, monthly averaged and extreme precipitation amounts, the annual probability of precipitation distribution, and the maximum and averaged monthly and annual snow fall. The reviewers found the information on severe weather, which includes dust, thunderstorms, lightning strikes, and range fires, to be acceptable.

4. The reviewers found the description of hydrology for the site and surrounding areas to be acceptable. The evaluation included the characteristics of nearby bodies of water and groundwater flows and the possibility of a flood accident because of failure of the Grand Coulee Dam. The U.S. Army Corps of Engineers evaluated the site's flood scenario and concluded that such a flood would not directly affect the site.

5. The reviewers found the description of the site's geology and the surrounding areas to be acceptable. The evaluation included the soil structure and seismicity of the site and the surrounding areas.

6. The reviewers found the description of the site's soil structure and seismicity to be acceptable. The evaluation included characteristics of all seismic sources in the site and the surrounding areas, such as magnitudes and frequency of recurrence of earthquakes, the travel path between the source and the site, and the attenuation effect of the geological materials in the travel path. The peak ground acceleration, seismic hazard curves, and seismic design response spectra of the site based on the site-specific seismicity were developed.

7. The reviewers found the description of natural phenomena and manmade external events, nearby facilities, and transportation to be acceptable. Natural phenomena such as seismic events, wind, snow, and flood were described. The manmade external events that were evaluated included aircraft activity and other transportation accidents near the site. The submittal also described nearby facilities and their possible effects to the site.

8. The reviewers found acceptable the submittal's statement that this submittal was consistent with the site EIS and its draft Emergency Response Plan as to the information on site characteristics.

3.1.3 Conclusions

The reviewers concluded that the submittal met the requirements of the site characteristics description for the PCAR. The submittal adequately provided all required information on site characteristics necessary for the hazard and accident evaluations.

3.2 Facility Description

The purpose of this review was to determine whether the submittal adequately described the facility features that were encompassed by the PCAR and that could affect any potential accidents (at the completed facility) and their consequences. Examples of these features are facility location, facility design information, and the location and arrangement of buildings on the facility site as well as the general arrangement, function, and operation of the major components in the process. This review was specific to the submittal, Volume I, *General Information*, as it related to facility description.

3.2.1 Requirements

The fundamental requirements for facility features are found in DOE/RL-96-0003, Section 4.3, "Authorization for Construction," which requires the Contractor to describe the facility systems, structures, and components (SSCs), including those designated as ITS.

BNI's SRD contains additional applicable requirements. SRD Safety Criterion 4.1-2 addresses SSCs designated as ITS and provides requirements that they be designed, fabricated, erected, constructed, tested, inspected, and maintained to quality standards commensurate with the ITS functions to be performed. Safety Criterion 4.1-3 addresses natural phenomena hazards (NPHs) design for SSCs that are ITS and have NPH safety functions, such as the ability to withstand the effects of earthquakes, wind, floods, missiles, volcanic ash, and snow loading. Safety Criterion 4.1-4 addresses NPH design for SSCs that are ITS without NPH safety functions.

The facility description was acceptable if it was presented at a level of detail appropriate to support the PCAR, if it identified and described the features that were ITS, and if the criteria outlined below were met to support complete hazard analyses:

1. The facility location and the distance from the site boundary in all directions, including the distance to the nearest resident, were provided.

2. The layout and location of buildings on the facility site were provided, using scaled drawings to show the plant layout, including plant structural features such as buildings, towers, tanks, and transportation right-of-ways. The relationship of specific facility features to the major processes that will be ongoing at the facility was described.

3. Design information was provided on the facility's ability to resist failures of ITS SSCs when those failures are caused by credible external and internal events and may produce consequences of concern. Also, information pertaining to the applicable design loads and various loading combinations was provided.

4. Information was provided on the imposed design limits that serve to quantify the structural behavior of the concrete and steel structures, specifically the required strength for various loading combinations.

5. Information was provided on the design and analysis processes used for the ITS structures.

6. Information was provided on ITS electrical systems and components.

7. Information was provided on ventilation and air cleaning systems and components.

8. Information was provided on protecting control room atmospheres.

9. Information was provided on effluent stacks.

3.2.2 Evaluation

The reviewers found the facility description acceptably met all nine of the review criteria. The submittal provided information on facility location and design in Chapters 1 and 2 of Volume I of the LAW PCAR submittal, calculation reports, other documents referenced in the PCAR, and responses to OSR questions related to the design and analysis of the basemat and interfacing walls. The evaluation of the information for each review criterion is summarized below:

1. The reviewers found the information on the facility location and distances between the LAW, HLW, and PT facilities and other adjacent buildings to be acceptable. The reviewers found the information regarding soil properties, NPHs (e.g., seismic, wind, flood, snow, and ashfall), and aircraft activity to be acceptable for basemat design load definition. In the LAW and HLW PCAR submittals, the site location was clearly identified to the extent needed for the PCAR. The Contract statement of work required the WTP facility to be located on this site. The reviewers considered the information provided to be acceptable for subsequent calculations of potential impacts to the environment and to the public from eventual operation of the LAW and HLW facilities.

2. The reviewers found acceptable the information on facility layout (described in Section 2.3.3) outlining the major processes that will be ongoing in the PT, HLW, and LAW facilities and at a detail appropriate to support the location of the LAW and HLW basemats. The relationship of the basemats and the interfacing structural walls and features to the major processes that will be ongoing at the facility are provided in Volume III of the LAW PCAR and in Volume IV of the HLW PCAR and were not evaluated here as part of the general information review.

3. The reviewers found acceptable the information (as described in Section 2.4) on the ability of the LAW and HLW building basemats and interfacing walls to resist failures of their ITS functions due to credible internal and external events. The reviewers' specific assessments were as follows:

    (a) The reviewers found the general information on required codes and standards to be acceptable because it met the requirements of SRD Safety Criteria 4.1-3 and 4.1-4.

    (b) The reviewers found acceptable the general information on (1) loads encountered by the basemat during normal plant operation, including dead loads, live loads, thermal loads, snow loads, ashfall loads, lateral earth pressure loads, wind loads, and flood loads, and (2) loads sustained during severe and extreme environmental conditions, including earthquake loads, accident thermal loads, and other postulated loads from drops. This information was acceptable because it was adequate to develop the design basis parameters necessary for the basemat's structural design. Additional facility-specific load definitions and information are provided in Volume III of the LAW PCAR and in Volume IV of the HLW PCAR and are discussed in Sections 4.1.1.2 and 4.2.1.2, respectively, of this SER.

(c) The reviewers found the information on various load combinations and load factors for the reinforced concrete basemats and interfacing walls to be acceptable because they were consistent with the requirements of the SRD Safety Criteria 4.1-3 and 4.1-4 codes and standards. Additional information was provided in Volume III of the LAW PCAR and in Volume IV of the HLW PCAR and is discussed in Sections 4.1.1.2 and 4.2.1.2, respectively, of this SER.

4. The reviewers found acceptable the general information on the imposed design limits related to the LAW and HLW reinforced concrete basemat and interfacing walls, described in Volume I of the LAW PCAR, because they were consistent with the requirements of SRD Safety Criteria 4.1-3 and 4.1-4. Additional information was provided in Volume III of the LAW PCAR and in Volume IV of the HLW PCAR and is discussed in Sections 4.1.1.2 and 4.2.1.2, respectively, of this SER.

5. The reviewers found the general description on the LAW and HLW basemat design and analysis processes to be acceptable because it was consistent with SRD Safety Criteria 4.1-3 and 4.1-4 requirements. Specific information on structural boundary conditions and additional design and analysis processes were provided in Volume III of the LAW PCAR and in Volume IV of the HLW PCAR and is discussed separately in Sections 4.1.1.2 and 4.2.1.2, respectively, of this SER.

6. Information on design of the electrical systems and components, such as power supplies to buildings, was not provided because BNI considered it not required for the PCAR. The reviewers agreed that this information was not relevant to the basemat's structural design.

7. Information on ventilation and air cleaning systems and components was not provided, except for the temperature limitations on structural concrete that were based on the American Concrete Institute's (ACI) ACI 349-01 code requirements, *Code Requirements for Nuclear Safety-Related Concrete Structures*, relative to the HLW basemat design (see Section 4.2.1.2 in this SER). The reviewers agreed that adequate information was provided.

8. Information on protecting control room atmospheres was not provided because BNI concluded it was not relevant to, or required for, the basemat designs or for the LAW and HLW PCARs. The reviewers agreed that this information was not relevant to the basemat's structural design.

9. In Volume I of the PCAR, only general information on the location of the effluent stacks was provided because BNI did not consider the stack to be important to the structural design of the basemats and therefore not relevant to the stack's ability to withstand NPH events and off-normal conditions that may arise during plant operation. The reviewers found this to be acceptable. Additional information was provided in Volume III of the LAW PCAR and Volume IV of the HLW PCAR and is discussed in Sections 4.1.1.2 and 4.2.1.2, respectively, of this SER.

3.2.3 Conclusions

The reviewers concluded that the information in Volume I of the PCAR met the requirements of the facility description for the PCAR. The submittal adequately described the general facility description that could affect potential accidents at the completed facilities and that may have an impact on the structural design of the LAW and HLW basemats.

3.3 Hazard and Accident Analysis

The purpose of this review was to determine whether the submittal adequately described the process to be used to conduct the hazard and accident analysis and whether the process complied with the SRD and ISMP. The review was to evaluate the process for identifying and selecting internal and external design basis events (DBEs) as part of the accident analysis. The review was also to provide confidence that the methods used for the hazard and accident analysis, if properly applied, will result in facility design, construction, operation, maintenance, and deactivation in a manner that protects the health and safety of the workers, the public, and the environment. The review was specific to the submittal, Volume I, *General Information*, as it related to the hazard and accident analysis.

3.3.1 Requirements

The description of the hazard and accident analysis process was acceptable if it was presented at a level of detail appropriate to support the PCAR. As identified in the SRD, Appendix A, Section 4.0, "Hazard Evaluation," the hazard and accident analysis process was acceptable if it addressed the nine criteria for hazard and accident analysis:

1. **Identifying Hazards** – Hazards associated with the facility processes, design, and operations were systematically identified.

2. **Identifying Potential Accident/Event Sequences** – Potential accidents were examined in a structured, systematic approach.

3. **Estimating Accident Consequences** – The consequences for postulated accidents were examined.

4. **Estimating Accident Frequencies** – Internal and external accident frequencies were estimated.

5. **Considering Common-Cause and Common-Mode Failures** – Credible common-cause events were considered, such as natural phenomena events, external manmade events, loss of electrical power, fire, internal missiles, and internal flooding.

6. **Defining DBEs** – A set of internal and external DBEs was identified that defined a set of bounding performance requirements for the SSCs relied on to control the hazards.

For internal DBEs, the submittal was acceptable if it described the method used to identify and analyze internal DBEs and the process for assessing associated risks.[25] The submittal should also describe the process for binning internal DBE accidents according to the initiating events, accident phenomena, and identified control strategy. The submittal was acceptable if a process to select internal DBEs was identified that represented the highest consequence and if both the unmitigated consequences (as part of hazards identification) and mitigated consequences (as part of the accident analysis) for the identified DBEs were calculated.

For external DBEs, the submittal was acceptable if the process for selecting both the facilities' seismic events and the seismic design criteria was identified, including development of the seismic hazard curves and response data.[26] The seismic acceptance criteria should describe the process to compare the calculated seismic demand on ITS SSCs from the seismic analysis with the corresponding seismic capacity derived from the acceptance criteria of SRD-required implementing codes and standards.

The submittal was acceptable for other external DBEs if it described methods for assessing DBEs from wind, missiles propelled by wind, flooding, loads due to volcanic ash, loads due to snow, and man-made external accident events such as aircraft crashes.

7. **Defining the Operating Environment** – A set of bounding operating conditions in which ITS SSCs must function was identified. The operating environment included temperature, pressure, humidity, radiation levels, and chemical environment.

8. **Identifying Potential Control Strategies** – Potential hazard control strategies were identified to manage each potential accident.

9. **Documenting the Hazard Evaluation** – The hazard evaluation was documented in a Hazard Analysis Report.

In addition to the nine criteria for hazard and accident evaluation, the submittal was acceptable if it provided methods for identifying assumptions and analyzing uncertainty, as well as the assumptions that affect the estimation of the frequency or consequences for each potential accident. Significant uncertainties should be identified for evaluation during the facility-specific hazard and accident analysis.

The process for evaluating the chemical process safety of the design was acceptable if it was adequate to identify the chemical hazards and integrate the chemical accident analyses into the overall preliminary safety analysis.[27] The submittal was acceptable if BNI had implemented or committed to implement the 12 elements of a process safety management program as outlined in its SRD and ISMP;[28] if appropriate techniques, such as those described in the American Institute

[25] RL/REG-99-05, Section 4.5, "Internal DBEs."
[26] RL/REG-99-05, Section 4.6, "External DBEs."
[27] RL/REG-99-05, Section 7.3, "Acceptance Criteria."
[28] RL/REG-99-05, Section 7.2, "Areas of Review."

of Chemical Engineers (AIChE) *Guidelines for Hazard Evaluation Procedures*, were used for hazard evaluation and quantitative risk assessment; and if valid assumptions were used to assess the chemical process hazards.

3.3.2 Evaluation

The reviewers found the description of the hazard and accident analysis methods and process to be applied met all nine review criteria. The evaluation of the information for each review criterion is summarized below:

1. **Identifying Hazards** – The reviewers found the description of the process for identifying hazards for the facility processes, design, and operations to be acceptable, as described in Sections 3.3.1, 3.3.2, 3.3.2.1, and 3.3.2.2 of the submittal. The technique chosen was based on AIChE's recommendations in its *Guidelines for Hazard Evaluation Procedures*, which was consistent with the SRD, Appendix A, Section 4.1, "Identification of Hazards." This approach was also consistent with the other requirements associated with identifying the hazards, including SRD Safety Criteria 3.1-1 and 3.2-1 and the SRD, Appendix A, Section 4.2, "Identification of Potential Accident/Event Sequences." The AIChE methods include a complete analysis of all potential initiating events, including human error, with the preferred approach being a hazard and operability analysis technique. The PCAR stated that knowledgeable individuals from varying disciplines conducted the analysis, as required for the specific review in question.

   The submittal committed to address the characteristics of chemicals and potential process byproducts, including the use of a chemical interaction matrix for each facility and the development of documentation (i.e., a hazard map). The methodology described the commitment to provide facility-specific information on the chemical inventories, equipment capacities, energy sources, and other environmental conditions so that all hazards were identified. The submittal methodology does not require consideration of accidents resulting from holding chemicals for long periods because this was assumed to be prevented by normal operating procedures. The reviewers agreed that this approach was acceptable and was consistent with industry practice regarding process chemicals.

   The reviewers noted one area of concern. The hazards evaluation approach considered radionuclide concentrations and material inventories in LAW – derived from feeds to pretreatment – with those inventories at the Contract maximum values, except for additional restrictions placed on ^{125}Sb and ^{241}Am. Volume I of the submittal did not justify the rationale for placing restrictions on the concentrations of these two radionuclides. In response to Question LAW-PCAR-014 concerning radionuclide concentrations, BNI referenced calculations that assumed the LAW radionuclide concentrations and material inventories (source term) should be based on the LAW pretreatment processes and controls. The response was determined to be acceptable.

   Finally, the reviewers noted that the analyses considered doses to workers. The accident analysis methods, models, and parameters for offsite individuals were typically based on substantial experience where accepted protocols and methods had been established. However, the reviewers were not aware of any consensus methods or protocols that had been established for estimating worker doses during accidents. Further, because of the worker proximity to the accident and the variability of potential conditions, doses to facility workers from accidents can be difficult to quantify and will rely on engineering judgment. The OSR has evaluated this situation in a position paper on calculating facility worker doses.[29] The reviewers determined that the methods described in the submittal were consistent with the OSR position. Therefore, the worker accident dose methods were acceptable.

2. **Identifying Potential Accident/Event Sequences** – The reviewers found the definition of the methodology for identifying potential accident/event sequences to be acceptable, as discussed in Sections 3.3.2.1, 3.3.2.2, 3.3.5, 3.4.4, and 3.8 of the submittal. The method was to apply the ISM process to each WTP facility and design area, with different ISM teams assigned to each area, depending on the complexity and number of identified systems. This approach was consistent with SRD Safety Criterion 3.2-1 and the implementing codes and standards found in the SRD, Appendix A, Section 4.2, "Implementing Standard for Safety Standards and Requirements Identification."

   The ISM team was comprised of knowledgeable and qualified staff. In response to Question LAW-PCAR-011 concerning selection of the preliminary safety analysis team, BNI stated that potential team members were screened, beginning with basic resume reviews and interviews, and then trained. The ISM team was required to document the hazard, the initiating event, and the hazardous situation. The team could use various hazards identification techniques, ranging from applying engineering judgment to applying numerical methods, depending on the hazards involved with a particular system. In this manner, the ISM team would characterize the accident sequence for further review. The ISM team then recorded information on the unmitigated consequences and assumptions regarding accident/event frequencies in Standards Identification Process Database (SIPD)[30] records. Accident severity levels, as defined in Appendixes A and B of the SRD, were then assigned based on the unmitigated consequence estimates.

   The reviewers found that the methodology required that common-cause accidents be evaluated as part of the overall WTP Operations Risk Assessment, designed to provide confirmation that the facility will meet the prescribed radiological exposure standards in SRD Safety Criterion 2.0-1, the chemical risk exposure standards in SRD Safety Criterion 2.0-2, and the associated risk goals. The methodology for selecting potential accident sequences appropriately linked initiating events with prevention and mitigation control strategies through the ISM review process. The identified accidents were grouped by similar control strategies, release mechanisms, and consequences to develop a representative set of DBEs, which were the bounding events for each group of accidents

[29] ORP/OSR-2001-17, *The Office of Safety Regulation Position on the Calculation of Facility Worker Doses from Seismic and Non-Seismic Events*.
[30] BNI maintains the SIPD as a repository for the results of the hazard analysis and control strategy selection processes.

identified. Where data were lacking or incomplete, the methodology included appropriate conservatism. The reviewers determined that this approach to selecting DBEs and applying the identified ISM methods was both comprehensive and credible. The overall methodology considered secondary events caused by external conditions, such as accidents at nearby facilities and aircraft crashes. The reviewers determined that the criterion for determining when selected events were incredible and not subject to further analysis was that the initiating event frequency must be estimated to be much less than 10^{-6}/yr, which is conservative.

3. **Estimating Accident Consequences** – The reviewers found the methods for estimating accident consequences to be acceptable, as provided in Sections 3.3.2.3, 3.3.2.4, 3.4.2, and 3.4.3 of the submittal. The methods relied on estimating radiation doses using bounding unmitigated evaluations, which were recorded in control strategy development (CSD) records. The methods were consistent with SRD Safety Criteria 3.1-3 and 3.1-4 and the SRD, Appendix A, Section 4.3, "Estimation of Consequences." The methods for conducting quantitative dose evaluations to determine severity levels were found in 24590-WTP-GPG-SANA-004, *Design Guide: Radiological Consequence Analysis*.

   The reviewers determined that the submittal adequately described the basis for estimating unmitigated accident consequences that did not credit active or passive SSCs or administrative controls that could reduce the consequences of the accident. The design guide provided a complete description of the methods used to develop source terms and to evaluate downwind transport and consequences using appropriate methods and dose conversion factors to determine total effective dose equivalents. The methods applied the same five-factor formula found in Volume 2 of NUREG/CR-6410, *Nuclear Fuel Cycle Facility Accident Analysis Handbook*, and in DOE-HDBK-3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*. The methods included consideration of external radiation fields and exposure durations for each of the exposed populations. The reviewers determined that the submittal provided an appropriate method for evaluating the potential consequences of releases of hazardous chemicals, using Emergency Response Planning Guidelines or equivalent limits, consistent with the requirements of SRD Safety Criterion 2.0-2. As described in Item 2 above, the reviewers found that the criteria for binning accidents were acceptable.

4. **Estimating Accident Frequencies** – The reviewers found the definition of the process for estimating accident frequencies to be acceptable, as discussed in Sections 3.3.2.4, 3.4.5, and 3.8 of the submittal. In response to Question LAW-PCAR-016 concerning the technical basis used to estimate accident frequencies, BNI stated that the approach was defined in 24590-WTP-GPG-SANA-002, *Design Guide: Integrated Safety Management*, and was consistent with the requirements found in the SRD, Appendix A, Section 4.4, "Estimation of Accident Frequencies." The methods used considered both the frequency of the initiating event and the estimated frequency of failure (i.e., the reliability) of preventive and mitigative control strategies. The design guide provided an acceptable method for estimating frequencies considering engineering judgment, more quantitative methods, and the addition of margins to account for uncertainties induced by more qualitative methods.

5. **Considering Common-Cause and Common-Mode Failures** – The reviewers found acceptable the methodology for analyzing common-cause and common-mode failures and discussion of common-cause and common-mode failures, as found in Sections 3.3.5 and 3.4.1. These sections were consistent with the SRD, Appendix A, Section 4.5, "Consideration of Common Cause/Common Mode Failures." The methods included consideration of NPH events, external man-made events, loss of electrical power, fire, internal missiles from pressurized components and rotating equipment, and human error. The NPH events included earthquake, straight winds, missile propelled by wind, volcanic ash, storm-induced flooding, snow loading, and range fires.

   The analysis focused on identifying provisions to prevent the loss of safety functions resulting from credible common-cause failures, as discussed in 24590-WTP-GPG-SANA-002. The methodology required documenting assumptions that may affect the frequency or consequences for each potential accident, including those involving common-cause and common-mode failures. These assumptions were tracked and evaluated to determine if they induced uncertainties in either the estimated consequences or frequencies and if they influenced the design, work descriptions, or operational conditions. In response to Question LAW-PCAR-019 concerning accident dependencies, BNI stated that the process for evaluating severity levels for catastrophic failures during earthquakes for the LAW facility, including consideration of common cause failures, was documented in 24590-LAW-Z0C-S30T-00001, *Seismic Categorization of the LAW Facility*. A similar calculation was done for the HLW facility in 24590-HLW-Z0C-S30T-00001, *Design Basis Event: HLW Facility Seismic*. The reviewers determined that the hazard and accident analysis was conducted in a manner that accounted for uncertainties by providing conservative estimates of the initiating event and considering SSCs in the ISM process that prevent or mitigate a hazardous situation. This approach provided a conservative method for meeting the exposure standards and considered frequency and uncertainty.

6. **Defining DBEs** – The reviewers found acceptable the accident analysis process for defining DBEs, as described in Sections 1.5, 2.4, and 3.3.7 of the submittal. The process described for identifying facility-specific DBEs was consistent with SRD Safety Criteria 3.4-1 (Item 4), 4.1-3, 4.1-4, 4.1-5, 4.2-1, 4.2-2, and 4.2-3 (as implemented through the ISMP, Sections 1.3.4 and 5.5 (both entitled "Process Hazards Analysis") for internal and external initiating events. The reviewers also found that the submittal was consistent with the SRD, Appendix A, Section 4.6, "Definition of Design Basis Events," and with the selected standards.[31] However, a few deviations from the standards were noted. Instead of assigning a risk ranking matrix (similar to that described in AIChE's guidelines) to bin accidents for determining DBEs, a combination of control strategy, consequence, and accident type was used. Although a deviation, the general types of accidents identified were comprehensive and complete, and the reviewers found the approach to be acceptable. The details for conducting the hazard and accident analysis supporting the identification of DBEs was found in BNI's design guide, 24590-WTP-

[31] AIChE, *Guidelines for Hazard Evaluation Procedures*.

GPG-SANA-004. As described in Item 3 above, the design guide contained the five-factor formula and appropriate references to supporting documentation. For the seismic analysis, a probabilistic risk analysis using documented methods[32] will be conducted.

7. **Defining the Operating Environment** – The reviewers found acceptable the methods for defining and tracking the operating environment through the design process, as described primarily in Section 3.3.4 of the submittal. This section was consistent with Item 4 of SRD Safety Criterion 3.1-4, which requires that the hazard analysis consider the normal operational and accidental conditions. The submittal also was consistent with the SRD, Appendix A, Section 4.7, "Definition of Operating Environment," which required that the hazard evaluation define a set of bounding operating conditions within which SSCs relied on to control hazards must function. These conditions included temperature, pressure, humidity, radiation levels, and the chemical environment. The process relied on this information being identified as part of the ISM accident identification process. The environmental conditions to which ITS equipment may be subjected during each specific accident is established and entered into SIPD for tracking. Operating environmental parameters are specified on a case-by-case basis considering the characteristics of each identified accident.

8. **Identifying Potential Control Strategies –** The reviewers found the process for identifying potential control strategies, as primarily described in Section 3.3.3 in the submittal, to be acceptable. The method relies on the ISM process to evaluate the hazards and proposed control strategies relevant to the facility design, using ISM review teams. The teams are required by the process to ensure that the relevant SRD safety criteria and implementing codes and standards are included in identifying control strategies. Because DBEs were determined in part based on similarity of control strategies, identifying potential control strategies was an integral part of the hazard analysis approach.

9. **Documenting the Hazard Evaluation –** The reviewers found the commitment to document the results of the hazard evaluation, as discussed in Section 3.3.7 of the submittal, to be acceptable. For the basemats, the process requires the submittal to document the accident sequences, linking initiating events with preventive and mitigative measures relevant to the accident sequence progression, the rationale for sorting accidents for further evaluation, the description and binning of credible accident sequences, and an evaluation of external events.

   In response to Question LAW-PCAR-020 concerning binning of potential accidents, BNI stated that the procedures for identifying hazards and appropriate control strategies were found in 24590-WTP-GPP-SANA-002C, *Hazards Analysis Development of Hazard Control Strategies and Identification of Standards*, and 24590-WTP-GPG-SANA-002. As discussed in Item 3 above, the documentation in subsequent volumes of the submittal will consider both radiation doses and exposures to hazardous chemicals and will

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[32] RPT-W375-NS00005, *Seismic Probabilistic Risk Analysis Methodology.*

document the results of the DBE selection process. The reviewers verified that common-cause and common-mode events, including those resulting from natural phenomena, will be included in documenting the analysis of each facility in subsequent volumes of the PSAR. The reviewers determined that the analysis methods accounted for human error during maintenance activities. The reviewers noted that in the response to LAW-PCAR-020, BNI committed to address conservatism in the modeling and data and the role of conservatism in offsetting uncertainty, consistent with past safety analyses.[33]

The reviewers evaluated the process used to evaluate the chemical process safety of the design. The reviewers found the discussion of the 12 elements of a process safety management program, as required in the SRD and ISMP, to be acceptable. The description of the chemical process safety evaluation process was consistent with the preliminary level of design. Volume I of the LAW PCAR described the methodology used to conduct the preliminary hazard analysis, while Volumes III and IV (Tables 3-2, 3-3, and 3-4) provided chemical properties, hazards, and interactions. Appendix A included the accident sequences involving potential chemical hazards.

3.3.3 Conclusions

The reviewers concluded that the description of the methodology for conducting the hazard and accident analysis, including the process to be used to identify and analyze internal and external DBEs, was acceptable. The review provided confidence that the methods used for the hazard and accident analysis, if properly applied, will result in facility design, construction, operation, maintenance, and deactivation in a manner that protects the health and safety of the workers, the public, and the environment.

The reviewers concluded that the chemical process safety submittal was acceptable. The submittal adequately described the chemical process safety program in support of the PCAR, including the 12 elements of a process safety program.

3.4 Important-to-Safety SSCs

The purpose of this review was to determine whether the submittal adequately described a process for identifying and documenting the ITS SSCs and the most severe anticipated conditions under which they must function. This review was specific to the submittal, Volume I, *General Information*, as it related to the process to be used to identify facility-specific ITS SSCs.

3.4.1 Requirements

The submittal was acceptable if it described the process for identifying ITS SSCs and if the process considered the bounding operating conditions under which the SSCs relied on to control

[33] RL/REG-99-05, Section 4.4.3.3, Item 5, second paragraph, bullets 1 and 2, p. 4-21.

hazards must function. Environmental parameters to be addressed include temperature, pressure, humidity, radiation level, and chemical environment.[34] The operating environment during normal operations and under off-normal and accident conditions, as they would affect design related ITS SSCs, was considered in determining hazard control strategies.

The submittal was required to use a systematic process to identify the DBE characteristics, operating environment, and performance requirements and the results were expected to be justified and documented for each ITS SSC. The documented process was expected to use the following outline, to be repeated for each ITS SSC in the facility-specific submittals:[35]

1. **SSC Identification –** This identified the ITS SSC.

2. **Safety Function –** This defined the reason for designating the SSC as ITS and specifically identified its preventive or mitigative safety function(s) as determined in the hazard and accident analysis. The specific accidents associated with the safety function also were identified.

3. **System Description –** This described the ITS SSC and its safety function(s), its boundaries, and its interface points with other SSCs relevant to the safety function. When the ITS SSCs were described, the physical information known about the SSC was summarized.

4. **Functional Requirements –** This identified requirements that are specifically needed to fulfill safety functions. The functional requirement designation was limited to requirements necessary for the safety function. Functional requirements specifically addressed the safety relevant response parameters or nonambient environmental stresses related to an accident that determined the need for the ITS designation for the SSC.

5. **System Evaluation –** This provided performance criteria imposed on the ITS SSC to meet needed functional requirement(s) satisfying the identified safety function. In determining performance criteria for ITS SSC, existing criteria, such as single-failure criteria, were considered. The capabilities of the ITS SSC were evaluated and shown to meet the performance criteria. The evaluation was as simple as possible and relied on design, engineering judgment, calculations, or performance tests.

6. **Controls (technical safety requirements [TSRs]).** This identified assumptions associated with the ITS SSCs that require TSRs to ensure performance of the safety function.

[34] SRD, Appendix A, Section 4.7, "Definition of Operating Environment."
[35] RL/REG-99-05, Section 4.5.3.3.3, "Regulatory Acceptance Criteria."

3.4.2 Evaluation

The reviewers found the submittal on the process for identifying, evaluating, and documenting ITS SSCs to be acceptable. The evaluation of the information for each requirement is summarized below:

1. **SSC Identification –** The reviewers found the information provided on SSC identification in Sections 4.3 and 4.4 of the submittal to be acceptable. The ISM process required that each ITS SSC be specifically identified in the SIPD. ITS SSCs were designated safety design class (SDC) or safety design significant (SDS) using the approach described in the SRD, Appendix B, "Implementing Standards for Defense in Depth." The SSCs may be specified at the system level or at the major component level as specifically identified in the DBE analysis.

2. **Safety Function –** The reviewers found the documentation of the safety function of ITS SSCs to be acceptable. The ISM process, defined in BNI's K70DG528, *Design Guide – Integrated Safety Management*, required that the reason for designating an SSC as ITS, resulting from the hazard and accident analysis, be specifically identified and documented in the SIPD.

3. **System Description –** The reviewers found the description of the required information for SDC and SDS SSCs to be acceptable. Sections 4.3 and 4.4 of the PCAR committed to describe each ITS SSC and its safety function, supported by drawings and any other essential information.

4. **Functional Requirements –** The reviewers found the information on functional requirements to be acceptable. Sections 4.3 and 4.4 of the PCAR committed to identify the safety functional requirements of ITS SSCs. Functional requirements are specified for SSCs to address the environmental stresses that may be encountered. The accident scenarios are required to be identified using the most severe environmental conditions that could be encountered, and the information recorded and maintained as part of SIPD. These conditions encompass the operating environment for both normal operations and off-normal conditions. For an active SSC, the credited safety function is required to be preserved by applying the defense-in-depth principle so that the safety function is accomplished in spite of the failure. The DBEs include NPHs such as earthquakes.

5. **System Evaluation –** The reviewers found the information on system evaluation to be acceptable. Sections 4.3 and 4.4 of the PCAR committed to provide performance criteria imposed on the ITS SSCs to meet the functional requirements and satisfy the safety functions. The system evaluation is required to be as simple as possible, relying on design, engineering judgment, calculations, or performance tests.

6. **Controls (TSRs) –** The reviewers found the approach to produce a set of draft TSRs, as described in Sections 4.3 and 4.4 of the PCAR, when combined with the application of safety criteria, to be acceptable. The ISM process, as described in Section 3.3.3, included

definition of assumptions for developing TSRs to ensure that the SSCs can perform their safety functions.

3.4.3 Conclusions

The reviewers concluded that the submittal described and committed to the six requirements that will be included for each ITS SSC in facility-specific volumes of the submittal. The PCAR described and committed to an acceptable method for identifying and documenting the methods to be used to identify ITS SSCs.

3.5 Derivation of Technical Safety Requirements

Table S7-1 of the Contract requires that draft TSRs be submitted with the CAR. Information in this area will be submitted with BNI's LAW, HLW, and PT PSARs and will be evaluated for the full facilities. This was acceptable to the reviewers.

3.6 Criticality Safety Program

The basemat is not expected to be relevant to criticality safety and therefore was not part of the evaluation. Information in this area will be submitted with Volume I of the PSAR.. This was acceptable to the reviewers.

3.7 Radiation Protection

The purpose of this review was to determine if the submittal adequately described an acceptable Radiological Control Program (RCP) that protected the health and safety of facility and co-located workers and the public. The RCP describes the radiological safety program as it relates to nuclear facility safety and includes the Radiation Protection Program requirements of 10 CFR 835, "Occupational Radiation Protection." The review focused on the submittal, Volume I, *General Information*, as it related to radiation protection.

The radiological control submittal was acceptable if it addressed the functional elements from draft NRC Regulatory Guide 3.52, as required by the SRD,[36] and if it was consistent with other submittals, including the Radiation Protection Program, the draft submittal of the Environmental Radiological Protection Program (ERPP), the draft Deactivation Plan, and the draft Emergency Response Plan. BNI previously submitted[37] a Radiation Protection Program for design and construction in response to the requirements of 10 CFR 835 and the Contract, Section C, Standard 7, Item (e)(2)(ii), and Table S7-1. The Radiation Protection Program, a subset of the

[36] Appendix G, "Ad Hoc Implementing Standard for Safety Analysis Reports," Section 3.1, "Safety Analysis Report Preparation."
[37] CCN: 020735, Authorization Basis Change Notice ABCN-24590-01-00003, "RPP-Revised Applicability to Include All Activities Performed on the Hanford Site," dated June 27, 2001.

RCP, was limited to occupational radiation protection and compliance with the requirements of 10 CFR 835.

3.7.1 Requirements

For the RCP to be acceptable, it should have discussed the 13 functional elements from NRC draft Regulatory Guide 3.52 as identified separately below. Because the RCP is not required until authorization for production operations, many of the sections to be reviewed were in draft. The 13 areas to be reviewed were as follows:

1. **ALARA (As Low As Reasonably Achievable) Policy –** Policies and procedures used to ensure that radiation exposures will be maintained ALARA were described, as were the organizational structure, ALARA committees, and the application of trending analysis to maintain exposures ALARA.

2. **Organizational Relationships and Personnel Qualifications** – A detailed organizational chart for the RCP was provided, and the qualification requirements for the radiological protection personnel and assignment of specific responsibilities and authorities for key functions were identified.

3. **Radiological Control Procedures and Workplace Controls** – The program was described for identifying, developing, maintaining, and using approved written radiological control procedures and Radiation Work Permits (RWPs) for activities related to radiological control.

4. **Radiological Control Training** – The program to provide radiological control training for all personnel who have authorized access to a controlled area was described. Training objectives, management oversight, training methodology, identification of who is required to receive the training, content and frequency of training and refresher training, and the training effectiveness also were described. The OSR review of radiological control training was coordinated with the review of the overall performance based training and qualification system, which is described in Section 3.12 of this SER.

5. **Ventilation Systems** – Design of the ventilation systems was described, including specifications of the minimum flow velocity at hood openings, the types of filters and the maximum differential pressure across filters, and the planned frequency and types of tests required to measure ventilation system performance. Ventilation systems were reviewed in Sections 3.2.2 and 4.1.1.2 of this SER rather than in this section. Because of the stage of the WTP project, the adequacy of the ventilation systems will be reviewed in a later Safety Analysis Report submittal.

6. **Air Sampling** – Air sampling objectives and procedures for radiological controls were described, including the following:[38]

   a. Methods for analyzing airborne concentrations

   b. Methods for calibrating air sampling and counting equipment

   c. Action levels and alarm setpoints

   d. Basis used to determine action levels, investigation levels, and derived air concentrations and the minimum detectable activity for the radionuclides

   e. Frequency and methods of analyzing airborne concentrations

   f. Counting techniques

   g. Specific calculations and levels

   h. Action levels and investigation levels

   i. Locations of continuous air monitors, if used, and locations of continuous air monitor annunciators and alarms.

7. **Contamination Control** – The program to control radioactive contamination within the facility was described, including the following:[39]

   a. Types and frequencies of surveys

   b. Limits for removable and fixed contamination levels

   c. Methods and types of instruments used in the surveys

   d. Action levels and actions to be taken when the administrative controls or other limiting action levels are exceeded

   e. Types and quantities of contamination monitoring equipment

   f. Description of personnel (skin and clothing) contamination limits

   g. Minimum provisions for personnel decontamination

   h. Minimum types of protective clothing

   i. Release criteria for radiologically contaminated material

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[38] Draft Regulatory Guide 3.52, Section 5.6, "Air Sampling."
[39] Draft Regulatory Guide 3.52, Section 5.7, "Contamination Control."

j. Technical criteria and levels for defining contamination areas

k. Requirements for investigating personnel skin or clothing contamination

l. Requirements for frisking each time personnel exit a posted contaminated area

m. Criteria for leak checking sealed sources.

8. **External Exposure** – The program for monitoring personnel external radiation exposure was described, including the means to measure, assess, and record radiation dose to individuals. The type, range, sensitivity, accuracy, and frequency for analyzing personnel dosimeters were described. The submittal committed to participate in the National Voluntary Laboratory Accreditation Program to test dosimeters.

9. **Internal Exposure** – The program for monitoring personnel internal radiation exposure was described, including the means to measure, assess, and record radiation dose to individuals and the following:

   a. Criteria for determining when to monitor an individual's internal exposure
   b. Methods for determining the facility and co-located worker intake
   c. Frequency of analysis
   d. Minimum detection levels
   e. Action levels and actions to be taken based on the results.

10. **Combining Internal and External Dose Equivalents** – The program for combining internal and external dose to demonstrate compliance with the dose limits was described, including the procedure used for assessing an individual's doses according to specific regulatory and contractual requirements.

11. **Respiratory Protection** – The respiratory protection program for radiological controls was described, including the equipment to be used, the conditions under which respiratory protection is required for routine and nonroutine operations, the protection factors to be applied when respirators are used, and the locations of the facility's respiratory equipment.

12. **Instrumentation** – Requirements for measurement instrumentation for radiological controls were described, including the policy for maintaining and using operating instrumentation. The types of instruments that are available, as well as their ranges, counting mode, sensitivity, alarm setpoints, planned use, and frequency of calibration, were described.

13. **Hazard and Accident Analysis** – Postulated accidents that have radiological consequences for the facility and co-located workers were described. Also described were hazard and accident analysis results, the methodology for assessing the accident consequences, likelihood and risk associated with each accident sequence, controls for preventing or mitigating each accident sequence, and the levels of assurance applied to

the controls. The adequacy of the hazard and accident analysis was reviewed in Sections 3.3, 3.4, 3.5, and 4.0 of this SER rather than in this section.

3.7.2 Evaluation

The RCP was described in Chapter 7 of Volume I of the PCAR. Chapter 7 committed to implement the following documents as part of the RCP:

a. 24590-WTP-PL-NS-01-001, *Radiological Control Program*

b. BNFL-TWP-SER-003, Rev. 8, *Radiation Protection Program for Design and Construction* (updated 24590-WTP-RPP-ESH-01-001)

c. 24590-WTP-MN-ESH-01-001, *Waste Treatment Plant Radiological Control Manual*

d. 24590-WTP-PL-NS-01-002, *RPP-WTP Occupational ALARA Program*.

In response to Question LAW-PCAR-027 concerning where the 13 functional elements of the RPP could be found, BNI provided a cross-reference review matrix identifying the specific sections within the referenced documents where draft NRC Regulatory Guide 3.52 functional elements were implemented. The reviewers found the cited text in Chapter 7 of the submittal to be consistent with the Radiation Protection Program, the draft ERPP, draft Emergency Response Plan, and the draft Deactivation Plan.

The reviewers found 6 of the 13 elements of the RCP to be acceptable, 6 to be conditionally acceptable, and 1 (ventilation systems) not required for review. The results of the RCP evaluation are summarized below for the 13 functional elements of an adequate RCP. Many of the functional elements were in draft form because the RCP is not required to be fully in effect until authorization for production operations.

1. **ALARA Policy** – The reviewers found acceptable the commitments to policies and procedures used to ensure that radiation exposures are maintained ALARA. The submittal committed to develop formal plans and measures to apply the ALARA process to occupational exposures. The WTP Radiological Control Manual (RCM) and RPP-WTP Occupational ALARA Program identified responsibilities of the ALARA committee and the general organizational structure as it related to ALARA. Articles 132, 133, and 134 of the WTP RCM adequately addressed applying trending analysis, radiological performance goals, and radiological performance reports. Although these articles were not specifically cited in the cross-reference review matrix, BNI is committed to implementing them because Section 7.1 of the PCAR commits to the entire WTP RCM. Section 7.1 of the PCAR states, ". . .other key documents within the Radiological Control Program, and required by the Radiation Protection Program are *Waste Treatment Plant Radiological Control Manual* (24590-WTP-MN-ESH-01-001). . ."

2. **Organizational Relationships and Personnel Qualifications** – The reviewers found the description of organizational relationships and personnel qualifications to be conditionally acceptable. Draft NRC Regulatory Guide 3.52, Section 5.2, "Organizational Relationships and Personnel Qualifications," states, "The application should include a detailed organization chart that shows the Radiation Safety Organization and its relationship to senior plant personnel and other line managers, as well as job descriptions, authorities, and responsibilities of Radiation Safety personnel." Article 141 of the WTP RCM described the general characteristics of the radiological control organization and the relationship with line management. Chapter 6 of the WTP RCM identified qualification requirements for key radiation safety organization personnel. Chapter 17 contained the project organizational chart with a focus on design and construction management organizations. General information on responsibilities for key radiation safety functions was identified. However, a detailed organizational chart that showed the radiation safety organization and its relationship to senior plant personnel and other line managers was not provided. A dedicated radiation safety organization should be established to provide relevant support to line managers and workers. Job descriptions defining specific authorities and responsibilities of radiation safety organization personnel, as specified in draft Regulatory Guide 3.52, Section 5.2, also were not provided. In the SRD, Appendix G,[40] BNI indicated that organizational charts of the line organization and safety organization as well as a description defining qualifications, responsibilities, and authorities for each position related to safety will be provided in the Final Safety Analysis Report (FSAR). The reviewers agreed with the approach and identified this commitment as a condition of acceptance.

3. **Radiological Control Procedures and Workplace Controls** – The reviewers found the program for identifying, developing, maintaining, and using approved written radiological control procedures and RWPs for activities related to radiological control to be conditionally acceptable. The submittal committed to use written, approved procedures and RWPs to carry out activities related to the RCP. The *Quality Assurance Manual* (QAM), Policies Q-5.1 and Q-6.1, provided policies for reviewing and revising procedures. The WTP RCM identified when RWPs were required, what staff positions may approve RWPs, and what information is to be included in RWPs. However, it did not specify the review and revision cycle of procedures and did not describe the mechanism used for ensuring that RWPs are not used past their termination dates as specified in draft Regulatory Guide 3.52, Section 5.3, "Radiation Safety Procedures and Radiological Work Permits (RWP)." Although this information was not expected to be developed for the PCAR submittal, the review and revision cycle of procedures should be developed and provided to DOE before the start of the pre-operational testing phase[41] as a condition of acceptance, and the mechanism used for ensuring that RWPs are not used past their termination dates should be developed and provided in the FSAR.

[40] "Ad Hoc Implementing Standard for Safety Analysis Reports," Table G-2, "Planned Differences Between Regulatory Guide 3.52 PSAR and FSAR Content," Section 2.1, "Organization and Administration.
[41] SRD Safety Criteria 6.0-2 and 6.0-5.

4. **Radiological Control Training** – The reviewers found the description of radiological control training for all personnel with authorized access to a controlled area to be acceptable. Training objectives, management oversight, training methodology, identification of who is required to receive the training, content and frequency of training and refresher training, and evaluation of training effectiveness as it relates to radiological control were all discussed. (Training is also discussed in Section 3.12 of this SER.)

5. **Ventilation Systems** – The reviewers found the ventilation system description and policy to be acceptable for this stage of design. The submittal identified the policy that required using engineered controls to limit the intake of radioactive materials, including airflow from areas of lower contamination to areas of higher contamination. Because of the preliminary stage of the WTP project, the adequacy of the detailed ventilation system will not be determined in this SER but will be reviewed in a later Safety Analysis Report submittal.

6. **Air Sampling** – The reviewers found the air sampling program for radiological control to be conditionally acceptable. The WTP RCM described general requirements for air sampling and actions to be taken when action levels were exceeded. However, it did not adequately describe the following: the methods for analyzing airborne concentrations; methods for calibrating air sampling and counting equipment; action levels and alarm setpoints; the basis used to determine action levels, investigation levels, and derived air concentrations and minimum detectable activities for the radionuclides; the frequency and methods for analyzing airborne concentrations; counting techniques; specific calculations and levels; action levels and investigation levels; locations of continuous air monitors, if used; and locations of annunciators and alarms. Relevant information specific to air sampling should be located in program or safety documentation and referenced in the FSAR. While this level of information was not expected to be developed for this PCAR submittal, it should be developed and provided to DOE in the FSAR, as a condition of acceptance.

7. **Contamination Control** – The reviewers found the description of the program to control radioactive contamination within the facility to be conditionally acceptable. The WTP RCM described the types and frequencies of contamination surveys, release criteria for radiological contaminated material, monitoring requirements for personnel contamination, and minimum types of protective clothing. Article 221 of the WTP RCM discussed limits for personnel contamination for both removable and fixed contamination, technical criteria for defining contamination areas, and action levels when contamination limits are exceeded. Article 325 provided requirements on personal protective equipment and clothing. Appendix 3D provided guidelines for personnel contamination monitoring with hand-held instruments. Article 431 identified the requirements for leak testing sealed sources. Articles 222, 541, and 542 addressed minimum provisions for personnel decontamination and requirements for investigating personnel skin and clothing contaminations. Article 551 discussed general monitoring requirements. Although these articles were not specifically cited in the cross-reference

review matrix, BNI acceptably committed to contamination monitoring and control and committed to the entire WTP RCM in its submittal.[42, 43]

The facility's design features for controlling contamination were described in the PCAR. However, the PCAR did not adequately identify the types and quantities of contamination monitoring equipment and the methods and types of instruments used in the radiation surveys. Although this information was not expected to be developed for this PCAR submittal, it should be developed and provided to DOE in the FSAR, as a condition of acceptance.

8. **External Exposure** – The reviewers found acceptable the commitments for monitoring personnel external radiation exposure, including the means to measure, assess, and record radiation dose to individuals. Article 512.1 of the WTP RCM committed to PNL-MA-842, *Hanford External Dosimetry Technical Basis Manual*, which describes the type, range, sensitivity, accuracy, and frequency for analyzing personnel dosimeters. The submittal committed to having an external dose monitoring program that is accredited by the Department of Energy Laboratory Accreditation Program for personnel dosimetry, which is equivalent to the NRC's National Voluntary Laboratory Accreditation Program.

9. **Internal Exposure** – The reviewers found the commitments for monitoring personnel internal radiation exposure, including the means to measure, assess, and record radiation dose to individuals, to be acceptable. The WTP RCM described the criteria for determining when to monitor an individual's internal exposure, action levels, and actions to be taken based on results. Article 522.1 of the WTP RCM committed to PNNL-MA-860, *Methods and Models of the Hanford Internal Dosimetry Program*, and the PNL-MA-552, *Hanford Internal Dosimetry Project Manual*, which described the methods for determining worker intake; frequency of analysis; sensitivity and minimum detection levels; frequency of measurements; criteria for participation; and methods for determining worker intake from airborne radioactivity measurements, *in vivo* bioassay, *in vitro* bioassay, or a combination of these methods.

10. **Combining Internal and External Dose Equivalents** – The reviewers found acceptable the program for combining internal and external dose to demonstrate compliance with the dose limits, including the procedures used for assessing individual doses according to specific regulatory and contractual requirements.

11. **Respiratory Protection** – The reviewers found the respiratory protection program to be conditionally acceptable. The WTP RCM described equipment to be used and the conditions under which respiratory protection was required for routine and nonroutine

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[42] CCN: 017637C, J.O. Honeyman, CH2M Hill Hanford Group, to W.J. Taylor, ORP, "Response to the Office of Safety Regulation Questions Regarding the Radiation Protection Program, Revision 5A," 01-OSR-0025, dated January 24, 2001.
[43] CCN: 018020C, J.O. Honeyman, CH2M Hill Hanford Group, to W.J. Taylor, ORP, "Responsibility for Progression of the Radiological Protection Program for Design and Construction, Revision 5A is Transferred from CH2M Hill Hanford Group, Inc., to Bechtel National Inc.," 01-OSR-0050, dated February 12, 2001.

operations and committed to ANSI Z-88.2-1992, *American National Standard for Respiratory Protection*, which provides the protection factors to be applied when respirators are used. The WTP RCM and ANSI Z-88.2-1992 provided the requirements for training, control, use of respiratory equipment, mask fit testing, and breathing air purity. The PCAR described types of engineering and administrative controls that have been implemented to reduce the risk of internal exposure. However, the PCAR did not provide the locations of the facility's respiratory equipment. Although this information was not expected for this PCAR submittal, it should be developed and provided to DOE in the FSAR, as a condition of acceptance.

12. **Instrumentation** – The reviewers found the instrumentation program to be conditionally acceptable. The WTP RCM provided the policy for maintaining and using operating instrumentation and committed to ANSI N323, *Radiation Protection Instrumentation Test and Calibration*, which provides performance testing and calibration requirements. However, it did not adequately describe the radiation measurement selection criteria for performing radiation and contamination surveys, sampling airborne radioactivity, monitoring area radiation, and performing radiological analyses. The submittal did not list the types and quantities of instruments that were available, as well as their ranges, counting mode, sensitivity, alarm setpoints, and planned use, nor did it describe instrument storage, calibration, and maintenance facilities and laboratory facilities used for radiological analyses. The cross-reference review matrix indicated that not all 45 instrumentation has been determined for the project. Although this information was not expected to be developed for this PCAR submittal, it should be developed and provided to DOE in the FSAR, as a condition of acceptance.

13. **Hazard and Accident Analysis** – The adequacy of the hazard and accident analysis was not reviewed in this section but was evaluated in Sections 3.3, 3.4, 3.5, and 4.0 of this SER.

3.7.3 Conclusions

Based on a review of the submittal and BNI's response to Question LAW-PCAR-027 concerning radiological controls, the reviewers concluded that 6 of the 13 functional elements of an adequate RCP were acceptable, 6 were conditionally acceptable, and 1 (ventilation system) was not required for the PCAR review. The submittal committed to an RCP that protects the health and safety of the facility and co-located workers and the public. The submittal was consistent with other submittals, including the documented Radiation Protection Program, the draft submittal of the ERPP, the draft Emergency Response Plan, and the draft Deactivation Plan.

Conditions of Acceptance – BNI must include the following provisions in the Radiological Controls Program. Except for Item 2 below, these provisions must be provided with the FSAR:

1. Provide a detailed organizational chart that shows the radiation safety organization and its relationship to senior plant personnel and other line managers. Also, provide job

descriptions defining specific authorities and responsibilities of radiation safety personnel.

2. Specify the review and revision cycle of procedures and provide to DOE before the start of the pre-operational testing phase.

3. Describe the mechanism for ensuring that RWPs are not used past their termination dates.

4. Describe the methods for analyzing airborne concentrations; methods for calibrating air sampling and counting equipment; action levels and alarm setpoints; the basis used to determine action levels, investigation levels, and derived air concentrations and minimum detectable activities for the radionuclides; the frequency and methods for analyzing airborne concentrations; counting techniques; specific calculations and levels; action levels and investigation levels; locations of continuous air monitors, if used; and locations of annunciators and alarms.

5. Identify the types and quantities of contamination monitoring equipment and the methods and types of instruments used in the radiation surveys.

6. Identify the locations of the facility's respiratory equipment.

7. Describe the radiation measurement selection criteria for performing radiation and contamination surveys, sampling airborne radioactivity, monitoring area radiation, and performing radioactive analyses. List the types and quantities of instruments that are available, as well as their ranges, counting mode, sensitivity, alarm setpoints, and planned use. Describe the instrument storage, calibration, and maintenance facilities and laboratory facilities used for radiological analyses in the FSAR.

3.8 Hazardous Waste Management

Information on hazardous waste management was not required for the basemat PCAR. Information in this area will be submitted with Volume I of the PSAR. This was acceptable to the reviewers.

3.9 Waste Management

Information on waste management was not required for the basemat PCAR. Information in this area will be submitted with Volume I of the PSAR. This was acceptable to the reviewers.

3.10 Initial Testing, In-Service Surveillance, and Maintenance

Information on initial testing, in-service surveillance, and maintenance was not required for the basemat PCAR. Information in this area will be submitted with Volume I of the PSAR. This was acceptable to the reviewers.

3.11 Operational Safety

Information on operational safety was not required for the basemat PCAR. Information in this area will be submitted with Volume I of the PSAR. This was acceptable to the reviewers.

3.12 Procedures and Training

The purpose of this review was to determine whether the submittal adequately described the implementation of an acceptable procedures program that included a commitment to develop, review, control, and implement written procedures that adequately protect the facility and co-located workers, the public, and the environment during the partial construction activities. The review was also to determine whether BNI had defined an acceptable training and qualification program to reasonably ensure that site personnel have the knowledge and skills to perform the partial construction activities in a manner that adequately protects the health and safety of the workers. These reviews were specific to the submittal, Volume I, *General Information*, as it related to procedures and training.

3.12.1 Requirements

The requirements for procedures and training are identified separately below.
Procedures – The requirements for procedures are outlined in Section 3.5, "Procedures," of RL/REG-99-05. The submittal on procedures was acceptable if it met the following criteria:

1. Procedures were written or planned, as appropriate, for conducting operations involving controls identified in the preliminary safety analysis as ITS items and for all management control systems supporting those controls.

2. Management control procedures exist or were planned, as appropriate, to manage the following activities:

    a. Configuration management
    b. Radiation safety
    c. Maintenance
    d. Human factors
    e. QA
    f. Training and qualification
    g. Audits and assessments

h. Incident investigations
i. Records management
j. Nuclear criticality safety
k. Fire safety
l. Chemical process safety
m. Reporting requirements
n. Emergency management
o. Environmental protection

3. Methods for identifying, developing, approving, implementing, and controlling operating procedures were described.

4. The types of procedures that will be used were described and the areas requiring a procedure were clearly identified. These areas typically include management control, operating, maintenance, and emergency procedures. The submittal listed (in an appendix) the types of activities that are covered by written procedures.

5. The methods by which procedures will be reviewed and revised were described, as needed, following unusual incidents, such as an accident, significant operator error, equipment malfunction, or any system modifications.

6. The methods by which procedures were verified to be technically accurate and could be performed as written were described. The individuals responsible for verification were identified.

7. Issuance and distribution of procedures were documented and referred to the records management function.
8. The use and control of procedures were described.

Training – The requirements on training are outlined in Section 3.4, "Training and Qualification," of RL/REG-99-05. The draft Training and Qualification Plan and the description of the training program were acceptable if they met the following criteria:

1. BNI demonstrated that it was organized, staffed, and managed to facilitate planning, directing, evaluating, and controlling a systematic training process that fulfilled job-related training needs. A graded approach to training based on the results of the site hazard and accident analysis was in effect.

2. The training program provided for periodic retraining, based on specific criteria. Procedures for including operating experience feedback into the training program were described.

3. Minimum requirements were specified for selecting trainee candidates who perform actions relied on to prevent or mitigate accident sequences described in the hazard and accident analysis.

4. The tasks required for competent and safe job performance were identified, documented, and included in the training.

5. Learning objectives that identify training content and define satisfactory trainee performance were derived from job performance requirements.

6. Lesson plans and other training guides provided guidance and structure to ensure that training activities are conducted consistently and were based on the required learning objectives derived from specific job performance requirements.

7. Information was provided on evaluating trainees periodically during training to determine their progress toward mastering job performance requirements.

8. On-the-job training, if used for activities required by the hazard and accident analysis, was fully described.

9. A systematic evaluation of training effectiveness and its relation to on-the-job performance was used to ensure that the training program conveyed the required skills and knowledge and to revise the training, where necessary, based on the performance of trained personnel in the job setting.

10. A mechanism was used to ensure that feedback on unsafe practices, root cause investigations, and other operational human errors related to safety is integrated into continuing qualification training plans or special training sessions.

3.12.2 Evaluation

The results of the reviewers' evaluation of procedures and training are summarized separately below.

Procedures – The reviewers found three of the eight criteria were acceptably met and five were conditionally met. The procedures program was described in Section 12.3 of Volume I of the PCAR. In addition to the eight review areas, the evaluation included the design and construction phase procedures program as well as the proposed operational phase procedures program. The evaluation of the information for each review criterion is summarized below:

1. The reviewers found the procedure program to be acceptable for conducting operations involving controls identified in the PCAR as ITS items and for all management control systems supporting those controls. Administrative procedures relating to design, analysis, and construction of the LAW and HLW structures were reviewed and documented in OSR Inspection Report IR-01-013, *Safety Requirements Document Design Standards Implementation*. The procedure program met requirements. In addition, BNI had developed and implemented a formal process to develop, implement, and control procedures for design and construction activities associated with the PCAR

scope. BNI had also adequately described its planned program for developing, maintaining, controlling, and implementing procedures for the WTP's operating phase.

2. The reviewers found the management control procedures to be conditionally acceptable. The PCAR committed to working according to established management controls during design, engineering, and construction by implementing a Procedures Management System, which is part of the ISM system. In addition, in response to Question LAW-PCAR-103 concerning which management control procedures were in place, BNI committed to revising Section 12.3.1.1 as follows: "The project readiness assessment process determines the procedure set required to support Construction activities. Procedures are developed and issued before the activity governed by the procedure takes place." In response to the same question, BNI also committed to providing a table in Section 12.3.1.1 to indicate which activities were being addressed in management control procedures during design and construction, cold commissioning, and hot commissioning and operations. As a condition of acceptance, Section 12.3.1.1 must be revised with the first revision of the PSAR following authorization for construction.

3. The reviewers found the methods for identifying, developing, approving, implementing, and controlling operating procedures to be acceptable. The submittal adequately described its planned operations phase procedures program in Section 12.3.1.2, its planned operations phase procedure development in Section 12.3.2.2, and its planned operations phase procedure maintenance in Section 12.3.3.2 of the PCAR. Specifically, the submittal committed to providing procedures for a defined task or activity that accomplishes work or for activities defined in the QAM, authorization basis, or requirements documents. These procedures will incorporate applicable regulatory requirements and provide an auditable, traceable implementation of requirements. Procedures will be reviewed by affected departments and have identified owners. The procedure owner organization will perform a final assessment before approval to ensure compliance with requirements and management expectations. Procedure control will be provided by the Project Administration Document Control Department, which will allow WTP personnel access to controlled, current versions of approved procedures.

4. The reviewers found the identification of the types of procedures that will be used and the areas requiring a procedure to be conditionally acceptable. As noted in 2 above, the submittal committed to revising Section 12.3.1.1 to specifically state the management control procedures that are or will be in place to support the design and construction phase activities under the PCAR scope. In addition, in response to Question LAW-PCAR-106 concerning how procedures would be identified during the cold and hot commissioning stages, BNI committed to revising Section 12.3.2.2 as follows: "The procedures covering the following topics are in place as needed for the construction phase of the project. Changes and additions to the procedure set will be identified before cold commissioning and scheduled for completion before the activity taking place: major management control systems, system and facility operations (including control of hazardous processes), major maintenance activities (including safe work practices), hazardous materials control activities, radiological control activities, and emergency response activities (including radiological and hazardous chemical release)." The

reviewers found as a condition of acceptance that Section 12.3.2.2 must be revised with the first revision of the PSAR after authorization for construction.

5. The reviewers found the description of the methods for reviewing and revising procedures to be acceptable. Throughout Section 12.3, the submittal committed to review and revise procedures using a formal methodology. In Section 12.3.1.1, the PCAR indicated that updates, corrections, or improvements to the approved procedures are accomplished through user feedback. The management assessment and corrective action programs provide mechanisms for continuous improvement opportunities of both the procedures and the procedure process. In Section 12.3.3.1, the PCAR indicated that feedback and continuous improvement are integrated in the procedure management program through various processes, including lessons learned, procedure change processes, management and self assessments, periodic reviews, independent assessments, corrective actions, post-job briefs, and audits. In Section 12.3.2.2, the PCAR indicated that the need for a new or revised procedure may be identified under the following circumstances: when implementing modifications in conducting an operation, when modifying equipment or systems, when deeming a procedure inadequate during task performance, and when periodically reviewing technical procedures. The PCAR also indicated in Section 12.3.3.2.1 that procedure modifications can result from issues identified during training activities and from efforts to resolve occurrences resulting from personnel errors or equipment.

6. The reviewers found the methods by which procedures were verified as technically accurate and could be performed as written to be conditionally acceptable. The PCAR described the methods for verifying that procedures were technically accurate and able to be performed as written, including stipulating the types of individuals responsible for verifying that procedures meet appropriate standards and expectations. In Section 12.3.1.1 on design and construction phase procedures and in Section 12.3.1.2 on operational phase procedures, the PCAR committed to having the identified owner organization perform a final assessment before approval to ensure procedures were technically accurate and consistent with management expectations. The PCAR also committed that, before they are used by the end user, operational phase procedures (new and revised) will be validated, usually at the work location, to ensure their usability and correctness and that technical review and verification will ensure the technical accuracy of operational phase procedures by comparing them against appropriate source documents. In response to Question LAW-PCAR-104 concerning approval of WTP project procedures, BNI committed to revising Section 12.3.1.1 as follows to clarify who can approve procedures: "The procedure process is governed by the project procedure on procedures. It requires that management associated with ES&H [environment, safety, and health] and QA review new procedures and concur that they are or are not within the AB. ES&H and QA review changes to existing procedures if they affect the AB [authorization basis] or QA requirements. At a minimum, management associated with the relevant safety disciplines concurs with new procedures and changes to existing procedures that affect the AB requirements." As a condition of acceptance, Section 12.3.1.1 must be revised with the first revision of the PSAR following authorization for construction.

7. The reviewers found the description of documenting the issuance and distribution of procedures and referral to the records management function to be conditionally acceptable. The PCAR committed to forming the Project Administrative Document Control Department to provide a controlled delivery system that allows WTP personnel access to controlled, current versions of approved and released procedures. This delivery system will be electronic and will include an index that lists all approved procedures by title, number, and revision. In Section 12.3.1.2, the PCAR stated that line management would be responsible for supplying controlled copies of procedures and instructions at work locations and training workers on identifying and using the correct procedure revision. The procedure user is responsible for ensuring that the procedure to be used is the most current. In Section 12.3.2.2, the PCAR committed to implementing a process that ensures that WTP administrative and technical procedures are assigned a procedure and revision number, a record copy is placed in a procedure master file, and working and controlled copies of procedures are made available to procedure users. In response to Question LAW-PCAR-107 concerning the procedure change program and for consistency with the QAM, BNI committed to add the following language to Sections 12.3.3.1 and 12.3.3.2.1: "The project procedure complies with the WTP QAM and addresses permanent procedure revisions and expedited procedure changes." As a condition of acceptance, Sections 12.3.3.1 and 12.3.3.2.1 must be revised in the first revision of the PSAR after authorization for construction.

8. The reviewers found the description of the use and control of procedures to be conditionally acceptable. The PCAR committed to specific intervals for reviewing selected procedures to ensure that they remain technically accurate and appropriately human-factored. The specified frequency for periodic review is based on the safety importance of the procedures (e.g., procedures related to operation and maintenance of ITS SSCs and procedures related to implementing TSR requirements). In Section 12.3.1.2, the PCAR committed to implementing administrative procedures that will require procedure users to stop work if the work cannot be accomplished as described in the procedure or if accomplishing the work would result in an undesirable situation. In addition, this section committed to developing and using a protocol (e.g., a "classification code") for using technical procedures that includes designating procedures for use as "step-by-step" or "general intent." In response to Question LAW-PCAR-105 concerning use of technical procedures, BNI also committed to adding the following to Section 12.3.1.1: "For construction activities, the basic work planning process is based on the concept that for standard construction tasks, step-by-step work instructions are not required. A combination of technical specifications, field procedures and drawings are utilized to perform the work. Individuals involved in the work are trained to the requirements. The work is planned using a construction administrative procedure addressing construction work packages. When unique or complex tasks are performed, work planning is addressed in a construction administrative procedure addressing special instruction work packages. This procedure provides for the use of a work package with additional controls, including, where appropriate, step-by-step instructions." As a condition of acceptance, Section 12.3.1.1 must be revised in the first revision of the PSAR after authorization for construction.

Training – The reviewers found 5 of the 10 criteria to be acceptable and 5 to be conditionally acceptable. The training and qualification program was described in Chapter 12.4 of Volume I of the PCAR and in the Draft Training and Qualification Plan. The evaluation of the information for each review criterion is summarized below:

1. The reviewers found the description of the training system's organization and management to be acceptable. The PCAR committed to establishing a training department to plan, coordinate, and implement a training program for permanent and temporary positions that perform ITS work. The training program was supported by written procedures that apply to all WTP personnel and subcontractor employees. Responsibilities were defined for personnel involved in implementing the training program. Task-specific training and assessments were provided for manual and non-manual workers. A systematic approach to training, including needs and job analysis, was used to determine training needs and objectives.

2. The reviewers found the commitments to provide periodic retraining and the procedures for including operating experience feedback to be acceptable. The PCAR committed to provide refresher training that complies with periodic training requirements specified in applicable federal and state regulations and to maintain required certifications. Training will include provisions for lessons learned and operating experience feedback. Line managers will be responsible for the content and effective conduct of the training and qualification programs. Training records will be maintained according to Project Document Control procedures.

3. The reviewers found the description of trainee selection to be acceptable. The PCAR specified minimum requirements for selecting trainee candidates and committed to hire people who are qualified by education, training, and experience. All managers will be responsible for developing job specific training and minimum education and experience requirements.

4. The reviewers found the commitments to conduct needs/job analysis and to identify training tasks to be conditionally acceptable. The PCAR committed to identifying, documenting, and including tasks required for job performance in training. The PCAR also committed to using the systematic approach to training and linking tasks selected for training to supported procedures and training materials. The training department and subject matter experts will work together to create course material and recommend the method of instruction. Training will be modified or developed in a timely manner to respond to changing policy or procedures. A process to maintain WTP training materials current will track items that may affect the content of training programs and materials, including the job task analysis for positions affected by the changes. The training and development program will be systematically evaluated. However, the PCAR did not adequately define the periodic basis for comparing training materials with the list of tasks selected for training. The final training program must be revised to define the periodic basis for comparing training materials with the tasks to be performed. This must be done with the first revision of the PSAR after authorization for construction as a condition of acceptance.

5. The reviewers found the commitments to develop learning objectives as the basis for training to be conditionally acceptable. The PCAR committed to implementing learning objectives developed under the systematic approach to training. Course content will be based on course objectives developed by line management, subject matter experts, and the training department. The training programs will be structured commensurate with specific position needs. However, the learning objectives did not clearly state the knowledge, skills, and abilities the trainee must demonstrate and that learning objectives were sequenced based on their relationship to one another. The PCAR also did not adequately state the conditions under which required actions will take place and the standards of performance the trainee should achieve when completing the training. The final training program must be revised to correct these deficiencies with the first revision of the PSAR after authorization for construction as a condition of acceptance.

6. The reviewers found the instructing organization's commitments to use lesson plans and other training guides to be conditionally acceptable. The PCAR committed to using lesson plans or equivalent training guides for in-class and on-the-job training. Course content, including lesson plans and briefing guides, will be based on course objectives developed by line management, subject matter experts, and the training department. Training and qualification procedures will establish processes that project personnel use for conducting training and qualification programs. Qualification of personnel includes the trainee’s demonstrating skills and testing. However, the PCAR did not adequately define review and approval requirements for lesson plans, training guides, and other training materials before they are issued and used. The final training program must be revised to correct this deficiency with the first revision of the PSAR after authorization for construction as a condition of acceptance.

7. The reviewers found the commitments to evaluate trainees' mastery of learning objectives to be acceptable. The PCAR committed to evaluate trainees, to provide task-specific training and assessments, and to evaluate trainee mastery by administering written tests or demonstrating skills and knowledge presented in the classroom. An on-the-job item will not be completed until the trainee has demonstrated mastery of the item.

8. The reviewers found the commitments to conduct on-the-job training to be conditionally acceptable. The PCAR committed to conducting on-the-job training using organized performance-based training materials and to derive on-the-job training cards from task lists that will be updated as required. Trainee mastery will be evaluated by qualified on-the-job training instructors observing trainees’ demonstration of skills and knowledge during actual job performance and by trainees demonstrating skills and knowledge presented in the classroom. However, the PCAR did not adequately demonstrate that when the actual task cannot be performed and is walked-through, the conditions of task performance, references, tools, and equipment reflect the actual task to the extent possible. The final training program must be revised with the first revision of the PSAR after authorization for construction as a condition of acceptance.

9. The reviewers found the commitments to systematic evaluation of training effectiveness to be conditionally acceptable. The PCAR committed to systematically evaluating

training effectiveness and to having qualified individuals evaluate the training. Feedback from trainee performance during training and student course critiques will be used to evaluate and refine the training program. Changes will be monitored for their impact on training programs; and training will be modified or developed in a timely manner to respond to sources of feedback, changing requirements, and changing policy or procedures. However, the PCAR did not adequately demonstrate that it had established a defined, periodic basis for conducting training program evaluations. The final training program must be revised to correct this deficiency with the first revision of the PSAR after authorization for construction as a condition of acceptance.

10. The reviewers found the commitments to integrate feedback in training to be acceptable. The PCAR committed to ensure that feedback on unsafe practices, root cause investigations, and other operational human errors related to safety will be integrated into continuing qualification training plans or special training sessions. The training department and line management will respond to feedback from the configuration management system, quality program, and self-assessment activities to ensure personnel involved in the WTP project achieve and maintain the capabilities required to perform their assigned tasks safely. Performance-based training will be based in part on feedback from operational experience, lessons learned, and industry experience. Training will be modified or developed in a timely manner to respond to sources of feedback. Continuing training will include training in applicable industry operating experience with emphasis on knowledge and skills necessary to ensure safety.

3.12.3 Conclusions

The conclusions from the reviewers' evaluation of procedures and training are summarized separately below.

Procedures – The reviewers concluded that the procedure program was conditionally acceptable for the scope of activities requested under the PCAR submittal.

Conditions of Acceptance – BNI must complete the following changes to Section 12.3 of Volume I of the PCAR with the first revision of the PSAR after authorization for construction:

1. Revise Section 12.3.1.1 to state that, "The project readiness assessment process determines the procedure set required to support Construction activities. Procedures are developed and issued before the activity governed by the procedure takes place." Provide a table in Section 12.3.1.1 to indicate which activities are being addressed in management control procedures during design and construction, cold commissioning, and hot commissioning and operations.

2. Revise Section 12.3.2.2 to state, "The procedures covering the following topics are in place as needed for the construction phase of the project. Changes and additions to the procedure set will be identified before cold commissioning and scheduled for completion before the activity taking place: major management control systems, system and facility

operations (including control of hazardous processes), major maintenance activities (including safe work practices), hazardous materials control activities, radiological control activities, and emergency response activities (including radiological and hazardous chemical release)."

3. Revise Section 12.3.1.1 as follows to clarify who can approve procedures: "The procedure process is governed by the project procedure on procedures. It requires that management associated with ES&H and QA review new procedures and concur that they are or are not within the authorization basis. ES&H and QA review changes to existing procedures if they affect the authorization basis or QA requirements. At a minimum, management associated with the relevant safety disciplines concurs with new procedures and changes to existing procedures that affect the authorization requirements."

4. Add the following to Sections 12.3.3.1 and 12.3.3.2.1: "The project procedure complies with the WTP QAM and addresses permanent procedure revisions and expedited procedure changes."

5. Add the following to Section 12.3.1.1: "For construction activities, the basic work planning process is based on the concept that for standard construction tasks, step-by-step work instructions are not required. A combination of technical specifications, field procedures, and drawings are used to perform the work. Individuals involved in the work are trained to the requirements. The work is planned using a construction administrative procedure addressing construction work packages. When unique or complex tasks are performed, work planning is addressed in a construction administrative procedure addressing special instruction work packages. This procedure provides for using a work package with additional controls, including, where appropriate, step-by-step instructions."

Training – The reviewers concluded that the training and qualification description and the draft Training and Qualification Plan were conditionally acceptable. The submittal committed to obtaining and maintaining a well-qualified staff and to having a performance-based training process. Implementing the described training program should result in staff that are qualified and competent to design and construct the facility safely.

Conditions of Acceptance – BNI must complete the following changes to Section 12.4 of Volume I of the PCAR with the first revision of the PSAR after authorization for construction:

1. Define the periodic basis for comparing training materials with the list of tasks selected for training.

2. Clearly state in the learning objectives the knowledge, skills, and abilities the trainee must demonstrate; that learning objectives are sequenced based on their relationship to one another; the conditions under which required actions will take place; and the standards of performance the trainee should achieve when completing the training.

3. Define review and approval requirements for lesson plans, training guides, and other training materials before they are issued and used.

4. Demonstrate that when an actual task cannot be performed and is walked-through, the conditions of task performance, references, tools, and equipment reflect the actual task to the extent possible.

5. Define the periodic basis for conducting training program evaluations.

3.13 Human Factors

Information on human factors was not required for the basemat PCAR. Information in this area will be submitted with BNI's LAW PSAR. This was acceptable to the reviewers.

3.14 Quality Assurance

The purpose of this review was to determine whether the submittal adequately described the implementation of an acceptable QA program for items and activities ITS for partial construction, with particular emphasis on ensuring that the QAM had been developed according to the requirements of 10 CFR 830, "Nuclear Safety Management," Subpart A, "Quality Assurance Requirements." This review was specific to the submittal, Volume I, *General Information*, as it related to QA.

3.14.1 Requirements

Requirements for the QAM are found in the Contract,[44] which requires the RPP-WTP Contractor to use a technically defensible graded approach to develop the QA program. The purpose of the review was to determine whether the submittal adequately described the QA program to be used during partial construction. The OSR issued separate review guidance for the QAM: RL/REG-96-01, *Guidance for Review of the RPP-WTP Contractor Quality Assurance Program*. The OSR has approved BNI's QAM for construction.

3.14.2 Evaluation

The reviewers found the submittal on QA to be acceptable based on BNI's referral to its previously approved QAM. The QAM meets the requirements of 10 CFR 830, Subpart A, and was approved for design and construction by the OSR on August 2, 2001.[45]

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[44] BNI Contract No. DE-AC27-01RV14136, Standard 7, "Environmental, Safety, Quality, and Health," Section (e)(3), p. C-70.

[45] 01-OSR-0285, letter, R.C. Barr, OSR, to R.F. Naventi, BNI, "Contract No. DE-AC27-01RV14136 – Office of Safety Regulation (OSR) Partial Approval of Bechtel National, Inc. (BNI) Authorization Basis Change Notice

3.14.3 Conclusions

The reviewers determined that the submittal was acceptable in the QA area.

3.15 Emergency Preparedness

Additional information on emergency preparedness was not required for the basemat PCAR. A Construction Emergency Preparedness Plan is already in effect for BNI from the Limited Construction Authorization Agreement.[46, 47] This was acceptable to the reviewers.

3.16 Deactivation and Decommissioning

The purpose of this review was to determine whether the submittal described the design features for partial construction that will enhance facility decommissioning and help reduce radiation exposure of site personnel and the public. The review also examined the plans for preparing and retaining records important to deactivation and decommissioning (D&D). This review was specific to the submittal, Volume I, *General Information*, as it related to D&D.

3.16.1 Requirements

The requirements for D&D are found in DOE/RL-96-0003, Section 3.3.3, "Authorization for Construction," Item 9, and in Table S7-1 of the BNI Contract. Acceptance criteria were discussed in RL/REG-99-05, Section 11.0, "Deactivation and Decommissioning." The submittal on D&D was acceptable if the following criteria were met:

1. Design provisions were incorporated to facilitate deactivation and final decommissioning. These design provisions reduce radiation exposure to Hanford Site personnel and the public during and following D&D activities and minimize the quantity of radioactive waste generated during deactivation.

2. A draft deactivation plan provided details on how the facilities will be deactivated following completion of waste processing.

3. Plans were described for minimizing contamination. Guidance for minimizing contamination is provided in NUREG-1520, Section 10, "Deactivation and Decommissioning."

(ABCN) 24590-WTP-ESH-01-010, Revision A, Submittal of Quality Assurance Manual (QAM)," dated August 2, 2001.

[46] 01-OSR-0381, letter, H.L. Boston, ORP, to R.F. Naventi, BNI, "Contract No. DE-AC-01RV14136 – U.S. Department of Energy (DOE) Notice to Proceed with Limited Construction Activities," dated October 5, 2001.

[47] 01-OSR-0369, letter, R.C. Barr, OSR, to R.F. Naventi, BNI, "Contract No. DE-AC-01RV14136 – Office of Safety Regulation (OSR) Approval of Contract Deliverable Item 1-8, Occurrence Reporting," dated September 20, 2001.

In addition, BNI Contract specification C.7 (12) required functional design requirements that included process and facility design features to safely and efficiently facilitate deactivation, decontamination, decommissioning, and closure of the facilities according to the Resource Conservation Recovery Act.

3.16.2 Evaluation

The reviewers evaluated how installing the basemat will impact safe and efficient deactivation, decontamination, and decommissioning. Two of the three criteria were conditionally met, and one did not pertain to the partial construction of the LAW and HLW buildings. The evaluation of the information for each review criterion is summarized below:

1. The reviewers found the description of D&D planning and recordkeeping to be conditionally acceptable. Section 16.3.2 stated that sampling will be required to support D&D activities. Chapter 16 listed DOE O 430.1A, *Life Cycle Asset Management*, as a requirement. DOE O 430.1A, Section 6.G. (6)(a)(I), stated, in part, that the disposition process should provide for the site characterization and be updated as necessary to reflect changes in facility conditions throughout the process.

   In response to Question LAW-PCAR-029 concerning plans to assess pre-existing hazardous and radioactive conditions at the construction site, BNI described its radiological survey program during partial construction and stated that the Contract does not require installed design features to characterize the soils under the site buildings during or after operations. Instead, the facility relies on design features to contain contamination and prevent the release of dangerous waste to the soil, groundwater, surface water, or air. Clean closure of the soil beneath the WTP will be accomplished by maintaining facility integrity and therefore preventing contaminants from reaching the soil. While this approach to ensuring a safe and efficient D&D was acceptable, sampling will be required to characterize the site following operation and transition to D&D.

   Chapter 16 of the submittal presented many design actions, such as the selection of architectural materials, processes, and SSCs that will reduce occupational and public exposure during D&D. However, it did not specifically state the objective of reducing dose as required in the SRD. In response to Question LAW-PCAR-028 concerning radiation doses during D&D, BNI committed to make clear its commitment to reduce radiation exposure to Hanford Site personnel and the public during and following D&D activities. This was a condition of acceptance and must be completed with the first revision of the PSAR after authorization for construction.

   In Section 16.3.5, the PCAR committed that the facility will be designed to ensure that high-level radioactive waste, transuranic waste, mixed waste, hazardous waste, and low-level waste are identified, minimized, and disposed of to support the D&D process. This commitment was acceptable.

In Chapter 16, the PCAR committed to ensure the authorization basis documentation will be maintained to facilitate D&D. Deactivation endpoints will be established and the closeout documentation will include records of the verification methods. Transition readiness reviews will be performed, documented, and turned over to DOE consistent with DOE G-430.1-5, *Transition Implementation Guide*. Records of the basemat placement would fall in this category and be maintained pursuant to the QAM. This commitment was acceptable.

SRD Safety Criterion 8.0-2 states in part that, "Features and procedures that simplify and facilitate decommissioning…shall be identified during the planning and design phase based upon a proposed decommissioning method…." In questions LAW-PSAR-197 and 198, the reviewers asked how this safety criterion would be addressed for the C5 ventilation exhaust piping embedded in the HLW basemat. BNI responded to LAW-PSAR-197 by proposing to add the following statement to Section 16.3.5: "While the proposed decommissioning method has not been specified, the facility is being designed to limit contamination, facilitate decontamination, and minimize the dose and generation of waste in the event re-use or demolition of the facility is the ultimate decommissioning method." Because DOE has not yet stipulated the ultimate decommissioning method, the reviewers found that BNI's response to LAW-PSAR-197 was conditionally acceptable (to address options that could result in the greatest post operational dose and generation of waste). The change to Section 16.3.5 is a condition of acceptance and must be completed with the first revision of the PSAR after construction.

In response to LAW-PSAR-198, BNI stated that the *Operations Requirement Document* and the *Basis of Design* require coaxial piping, secondary containment, leak detection, etc., to be used to minimize the impact of spills and the ability of piping and equipment to be decontaminated. This indicates that the design of pipe or ducting containing radioactive or dangerous fluids under normal use and anticipated accidents will include provisions to minimize the impact of spills and the ability to be decontaminated to facilitate reuse or demolition of the WTP. BNI also explained how the embedded HLW C5 ventilation piping met the design criteria and concluded the design will limit contamination, facilitate decontamination, and minimize both dose and the generation of waste in the event of re-use or demolition of the facility. The reviewers found that the BNI response to LAW-PSAR-198 was acceptable.

2. The deactivation plan was not required nor submitted for partial construction of the LAW and HLW buildings. The draft deactivation plan will be submitted with the CAR, and its review will be addressed in the LAW/HLW construction authorization SER. This was acceptable to the reviewers.

3. The reviewers found the description of plans for minimizing contamination to be conditionally acceptable. The submittal described engineering methods and procedures to limit and control contamination, including design methods, process, and administrative controls. Section 16.3.1 incorrectly referred to R1, R2, and R3 as contamination classifications. In response to Question LAW-PCAR-030, BNI said that they would

revise the section to use notations consistent with current practices.[48] This must be completed with the first revision of the PSAR after authorization for construction.

3.16.3 Conclusions

The reviewers concluded that the D&D commitments were conditionally acceptable. The submittal adequately described how D&D principles were factored into the facility design and construction. The reviewers concluded that BNI had committed to design features that will facilitate decommissioning of the facilities and maintaining the documents necessary to facilitate decontamination.

Conditions of Acceptance – BNI must complete the following changes to Chapter 16 of Volume I of the PCAR, or the draft deactivation plan, with the first revision of the PSAR after authorization for construction:

1. In Chapter 16 or in the draft deactivation plan, clarify its commitment to reduce radiation exposure to workers and the public during and following D&D.

2. Add the following statement to Section 16.3.5: "While the proposed decommissioning method has not been specified, the facility is being designed to limit contamination, facilitate decontamination, and minimize the dose and generation of waste in the event reuse or demolition of the facility is the ultimate decommissioning method."

3. Change the R1, R2, and R3 contamination classifications listed in Section 16.3.1 consistent with current practices, i.e., C1, C2, C3, and C5 classifications.

3.17 Management, Organization, and Institutional Safety Provisions

The purpose of this review was to determine whether the submittal adequately described management systems and structures and the qualifications for key management positions. The review also assessed whether the submittal had described provisions for planning, implementing, and controlling site activities in a manner that protects the safety of the facility and co-located workers, the public, and the environment. Other elements in this review were the configuration management, audits and assessments, incident reporting and investigations, and records management programs. This review was specific to the submittal, Volume I, *General Information*, as it related to management, organization, and institutional safety provisions.

[48] 24590-WTP-GPP-7RAD-007, "Code of Practice for Classification of Areas," and RPT-W375LV-NS00001, "Classification of Areas Report for LAW."

3.17.1 Requirements

The requirements for organization and administration, configuration management, audits and assessments, incident reporting and investigations, and records management programs are identified separately below.

Organization and Administration – The requirements for organization and administration are found in DOE/RL-96-0003, Section 3.3.3, "Authorization for Construction," Item 1. Criteria for acceptance are found in RL/REG-99-05, Section 2.0, "Organization and Administration." The submittal was acceptable if the following criteria were met:

1. Corporate and Contractor policies contained a strong commitment to safety and protection of worker health and the environment.

2. The responsibilities of the specific organizations and organizational groups responsible for performing ITS activities during the facility design and construction phases were described. Organizational charts were included.

3. Clear management controls and communications among the organizational units responsible for designing and constructing the facility were provided.

4. Substantive breadth, level of experience, and availability of personnel to complete the facility's design, construction, and preoperational testing were demonstrated. Position descriptions clearly defined the qualifications, responsibilities, and authorities for key supervisory and management positions responsible for health, safety, and the environment. The descriptions will be accessible to affected personnel and to reviewers upon request. The submittal described how the organization (e.g., management and supervisory positions) will be structured to perform ITS activities as the facility transitions from design to construction and from construction to operation.

5. In the organizational hierarchy, the ES&H oversight organization(s) were shown to be independent of the operational organizations, allowing them to provide objective audit, review, or control activities. (As used here, "independent" means that neither organization reports to the other administratively; however, both may report to a common manager.) Lines of responsibility and authority are clearly drawn.

6. The activities essential for effectively implementing the ES&H programs were documented in formally approved written procedures that comply with a formal document control program.

7. A simple mechanism was available for all employees for reporting potentially unsafe conditions or activities to the ES&H organization and/or to upper management.

8. Effective lines of communication and authority were clearly defined and exercised among the organizational units involved in the facility's engineering and ES&H functions.

9. Formal management control systems were identified to ensure the availability and reliability of ITS SSCs.

10. Arrangements were in place for providing emergency resources such as fire, police, ambulance/rescue units, and medical services.

Configuration Management – The requirements for configuration management (CM) are found in the SRD, Chapter 4.0, "Engineering and Design," and Chapter 7.0, "Management and Operation." Acceptance criteria for CM are found in RL/REG-99-05, Section 3.1, "Configuration Management." The submittal was acceptable if the following criteria were met:

1. The overall CM program, which may be applied in a graded approach, described at least the following:

   a. The scope of the ITS SSCs to be included in the CM program
   b. Each CM program activity and its objectives
   c. Each CM program activity's organizational responsibilities and staffing interfaces.

2. Design requirements and associated design bases were demonstrated to be established and maintained by an appropriate organizational unit. The CM program, supported by the project schedule logic, ensured that design activities do not start until appropriate design criteria are established. The design criteria and bases for those ITS SSCs were identified.[49]

3. An acceptable method was described whereby documents are specified, prepared, reviewed, approved, stored, and maintained according to approved procedures and instructions. Measures were established to ensure that documents were legible, identifiable, retrievable, and protected against damage, deterioration, or loss.[50] A process was described for ensuring that current documentation, including revisions, was distributed and used to perform work activities.[51] The types of documents controlled were listed and included essential documents, such as drawings, procurement specifications, engineering analyses, and training/qualification records.[52]

4. The review of authorization basis changes before they are implemented was described to ensure that the impact on safety was analyzed and acceptable. An acceptable change control process was described to ensure that changes to the authorization basis are systematically reviewed. The process was consistent with RL/REG-97-13, *Regulatory Unit Position on Contractor-Initiated Changes to the Authorization Basis.*

Audits and Assessments – The requirements for audits and assessments are found in Subpart A of 10 CFR 830. Criteria for acceptance of audits and assessment are found in RL/REG-99-05,

[49] ISMP, Section 8.0, "Document Control and Maintenance."
[50] Initial Safety Analysis Report, Section 3.8, "Records Management."
[51] QAM, Policy Q-06.1.
[52] ISMP, Chapter 8.0, "Document Control and Maintenance."

Section 3.6, "Audits and Assessments." The submittal was acceptable if it committed to objectively evaluate the effectiveness and implementation of ITS activities and if the following criteria were met:

1. The frequency and scope for audits and assessments, including reviews of activities pertinent to safety and environmental protection, were described.

2. The qualifications and responsibilities of the manager responsible for the audit and assessment activity were identified.

3. For independent assessments, the group performing independent assessments was given sufficient authority and freedom from the line organization to carry out their responsibilities.

4. A process was described for the management to assess their management processes.

5. Audits and assessments were demonstrated to be conducted according to written procedures and checklists. Deficiencies noted during audits and assessments were communicated to appropriate management for prompt resolution.

6. Findings and recommendations and their distribution to appropriate management for review and response were documented. A corrective action program was described for ensuring that corrective actions were properly controlled.

7. For areas pertinent to facility construction, BNI was prepared to implement the audits and assessments program when initiating construction.

Incident Reporting and Investigations – The oversight process requirements are established in DOE/RL-96-0003, Section 3.3.5, "Oversight Process Determination," and in Table S7-1 of the BNI Contract. Acceptance criteria for incident reporting and investigations are found in RL/REG-99-05, Section 3.7, "Incident Report and Investigations." The submittal was acceptable if the following criteria were met:

1. A suitable standard for incident reporting and investigation for construction was provided.

2. A program was described and included a Construction Occurrence Reporting Plan that was consistent with the incident reporting and investigation standard.

3. A draft Occurrence Reporting Plan and a draft Plan for Operational Assessment Reports were provided.

Records Management – The requirements for records management are found in SRD Safety Criterion 4.0-3 and in Subpart A of 10 CFR 830. Acceptance criteria for records management are found in RL/REG-99-05, Section 3.8, "Records Management." The records management submittal was acceptable if it committed to a records management system that described quality requirements for ITS SSCs records and if the following criteria were met:

1. As stipulated in Subpart A of 10 CFR 830, ITS records were specified, prepared, reviewed, approved, and maintained.

2. ITS records were legible, identifiable, and retrievable for their designated lifetimes.

3. ITS records associated with ITS SSCs were protected against tampering, theft, loss, unauthorized access, damage, or deterioration while they are in storage.

4. Procedures were established and documented, specifying the requirements and responsibilities for selecting, verifying, protecting, transmitting, distributing, retaining, maintaining, and disposing of QA records.

5. The organization and procedures were in place to promptly detect and correct any deficiencies in managing records or implementing ITS records.

3.17.2 Evaluation

The individual areas reviewed were evaluated separately and are summarized below.

Organization and Administration – The reviewers evaluated the organization and administration description and found it to be acceptable. BNI's response to Question LAW-PCAR-038 concerning its corporate policy on safety demonstrated a strong corporate commitment to safety and protection of worker health and the environment. The overall management structure and organization, referenced as Figure 1 in the QAM, Policy Q-01.1, was appropriate for design and construction. The ES&H oversight organization was independent of the other parts of the operation, ensuring that ES&H priorities were not sacrificed to another line mission or objective. Based on review of the submittal, Attachment 8, "Contractor's Technical and Experience Qualifications to Construct the Plant," the key supervisory and management personnel were judged to have substantive breadth and level of experience.

Configuration Management – The reviewers evaluated the description of the CM program in Section 17.4.3 of the submittal and as referenced in the ISMP, Section 1.3.16, "Configuration Management." Of the four criteria, three were found to be acceptably met and one was conditionally met. SRD Safety Criterion 4.0-1 committed to use ISO 10007, *Quality Management, Guidelines for Configuration Management*, as the standard for developing and implementing the CM program for the RPP-WTP. The description of the CM program was consistent with this standard. The evaluation of the information for each review criterion is summarized below.

1. The reviewers found the CM program description to be conditionally acceptable. The evaluation of the information of each subelement of that description is summarized below:

a. The reviewers found the description of the CM program scope to be acceptable. The submittal stated that the CM program will provide direction for identifying and documenting the physical and functional characteristics of facility SSCs and computer software. Section 1.3.16, "Configuration Management," of the ISMP described the CM approach, which included identifying and documenting configured items. Selection of configured items considered the functional and physical characteristics that can best be managed to achieve the overall WTP project performance objectives related to radiological, nuclear, and process safety. In this regard, the ISMP identified items for CM that included SSCs, plant installed software, project interfaces, and authorization basis documents.

b. The reviewers found the description of the CM program activities and objectives to be acceptable. Section 1.3.16 of the ISMP described the four-step CM approach that would be used: (1) identification and documentation, (2) change control, (3) status tracking and reporting, and (4) configuration audit. Each step and its objectives were described in detail.

c. The reviewers found the description of the CM program's organizational responsibilities and staffing interfaces to be conditionally acceptable. Neither the LAW PCAR nor the ISMP contained details of the program's organizational responsibilities and staffing interfaces. Similar issues were noted during the OSR CM Inspection in May 2002. Corrective actions were identified in the OSR inspection and will be tracked to completion. In response to Question LAW-PCAR-005 concerning staffing interfaces, BNI committed to add to Section 17.4.3 of the PCAR specific information that described the CM program's organizational responsibilities and staffing interfaces. This must be completed in the first revision of the PSAR following authorization for construction as a condition of acceptance.

d. The reviewers found the description of essential elements used to maintain design configuration to be acceptable. Section 1.3.16.3, "Change Control," of the ISMP committed to a formal, proceduralized CM process for controlling design configuration. The process included documentation, engineering evaluation, approval, and implementation controls.

2. The reviewers found the description of design requirements in the PCAR to be acceptable. The PCAR committed to compiling Contract, basis of design, functional specification, operational requirements document, and authorization basis design requirements in a Microsoft Access® database – the Design Criteria Database. The CM organization is responsible for maintaining the database to integrate design requirements, safety standards, and operational requirements. The PCAR also committed to not initiate design activities until appropriate design criteria are established.

3. The reviewers found the description of document control in the PCAR to be acceptable. The PCAR committed to establishing document control procedures that prescribe the process for preparing, reviewing, approving, storing, and maintaining specified project

documents in either hard copy or electronic media, as well as ensuring that current and technically accurate documents are available to and used by individuals performing work at the work locations. The PCAR referenced Table 8-1, "Safety Management Records," of the ISMP for specifying project documents that are subject to document control; the documents in this table include those essential to ensuring that quality and safety are maintained. In addition, the PCAR committed to complying with QAM Policies Q-05.1, Q-06.1, and Q-17.1 for developing and controlling documents and for maintaining associated quality records.

4. The reviewers found the description of change control to be acceptable. The PCAR described and committed to a change control process under its CM program that includes the required elements of documentation, evaluation, approval, and implementation. The CM program will ensure that the change and the reasons for it are described and documented, the impact on related documents is identified with necessary changes considered, approval of changes is commensurate with the process applied to the original configuration, and changes are implemented and controlled through formal processes and procedures.

Audits and Assessments – The reviewers found the description of the audits and assessments program and all seven review criteria to be acceptably met. The reviewers evaluated Section 17.4.2 in the submittal, which addressed management and independent audits and assessments and referred to the QAM, Policies Q-18.1 and Q-18.3. The reviewers evaluated these two policies for each item in the review guidance and found each item to be adequately addressed. Subsection 17.4.2 did not address the procedures for ensuring that identified deficiencies were corrected in a timely and effective manner. However, this was addressed under QAM Policy Q-16.1, which is part of the authorization basis previously approved by the OSR. The evaluation of the information for each review criterion is summarized below:

1. The reviewers found the description of the frequency and scope of independent audits and assessments, including schedules, in Sections 3.2 and 3.3 of QAM Policy Q-18.1, to be acceptable. In QAM Policies Q-18.1, Q-18.2, and Q-16.1, the submittal described guidance for conducting the audits and surveillances, assignment of responsibilities for each phase of the work, procedures for recording the results of the audits and assessment activities, and assurance that identified deficiencies were corrected in a timely and effective manner. QAM Policy Q-18.3 identified the frequency and scope for management audits and assessments, guidance for conducting the audits, and assignment of responsibilities.

   In response to Question LAW-PCAR-034 concerning the procedures for recording the results of management assessments, BNI stated that the requirement to record the results of management assessments and the scope of management assessment reports was addressed in 24590-WTP-GPP-MGT-002, *Management Assessments*. This was acceptable to the reviewers.

2. The reviewers found acceptable the identification of the qualifications and responsibilities of the manager responsible for the independent audit and assessment

activity in QAM Policy Q-18.1 and of the managers responsible for the management assessment activity in QAM Policy Q-18.3. In response to Question LAW-PCAR-034 concerning documentation of qualifications for the audit manager and for personnel responsible for audit and assessment activities, BNI stated that qualifications of all BNI personnel were established and documented in position descriptions and were verified at the time individuals were hired. Qualification requirements for independent audit and assessment personnel were contained in QAM Policy Q-02.3. BNI also noted that management assessments were considered a normal job activity and that a management assessment procedure defined how to conduct the assessments. This was acceptable to the reviewers.

3. The reviewers found acceptable the description of the provision for sufficient authority and freedom from the line organization for the group performing independent assessments, as found in Section 3.5 of QAM Policy Q-18.1.

4. The reviewers found the description of management assessments of management processes, found in QAM Policy Q-18.3, to be acceptable.

5. The reviewers found the commitment to conduct audits and assessments according to written procedures and checklists, as found in Sections 3.4.2 and 3.7.2 of QAM Policy Q-18.1, to be acceptable. The policy committed to communicating deficiencies noted during audits and assessments to appropriate management for prompt resolution.

6. The reviewers found the description of the process for documenting findings and recommendations and distribution to appropriate management for review and response, as found in QAM Policy Q-18.1, to be acceptable.

7. The reviewers found the description of the following safety areas and management control systems to be addressed in audits and assessments to be acceptable: radiological controls, nuclear criticality safety (as appropriate), chemical process safety, fire safety, emergency management, environmental protection, QA, CM, maintenance, training and qualification, procedures, human factors, incident investigation, and records management.

Incident Reporting and Investigations – The reviewers found the description of incident reporting and investigation to be conditionally acceptable. The reviewers found one of the three criteria to be acceptably met, one to be conditionally met, and one not required for the basemat PCAR. The evaluation of the information for each review criterion is summarized below:

1. The reviewers found the commitment to a suitable standard for incident reporting and investigations for construction to be acceptable. The submittal referenced SRD Safety Criteria 7.7-1 through 7.7-8 and Sections 1.3.17, 3.16.3, and 5.6.7 of the ISMP as the appropriate standards for incident reporting and investigations.

2. The reviewers found conditionally acceptable the commitment, in Section 17.4.7, that the construction occurrence reporting would be done according to DOE O 232.1A, *Occurrence Reporting and Processing of Operations Information*; its associated DOE Manual 232.1-1A; and BNI procedure 24590-WTP-GPP-SIND-001-0, *Reporting Occurrences in Accordance with DOE Order 232.1A*.

   Question LAW-PCAR-037 asked whether the referenced BNI procedure, 24590-WTP-GPP-SIND-001-0, could be used for partial construction because the procedure's scope stated it was relevant to activities and hazards that could be encountered during the project's design and limited construction phase. BNI responded that although the scope of the procedure was only for limited construction, the procedure had been developed to address hazards and activities that would be expected to occur during the project's full construction phase. BNI re-evaluated the procedure for hazards and activities that would be associated with work performed during the project's partial construction phase and determined work activities and hazards experienced then would be less severe than hazards associated with the full construction phase. Therefore, the procedure was applicable during partial construction. However, in the question response, BNI said that the procedure would need to be revised to address hazards and activities for the cold commissioning phase. This is a condition of acceptance for the PCAR.

   Question LAW-PCAR-032 asked about the exclusion of SRD Safety Criterion 7.7-9 from occurrence reporting requirements. Criterion 7.7-9 required BNI to ensure that subcontractors and suppliers report defective items, materials, and services and that BNI must specify the requirements in applicable documents. BNI responded that Safety Criterion 7.7-9 was implemented by the QAM. The reviewers verified this and found the response to be acceptable.

3. The draft Occurrence Reporting Plan (for operations and hot commissioning) and Plan for Operational Assessment Reports were not submitted with the PCAR. The two documents will be submitted with the LAW PSAR. This was acceptable to the reviewers.

Records Management – The reviewers found the description of records management and all five review criteria to be acceptable. For this area, the reviewers evaluated Section 17.4.4 of the submittal, which referred to the QAM, Policies Q-05.1 and Q-06.1, to describe the project document control system and to Policy Q-17.1 for controlling records to ensure they are legible, identifiable, retrievable, and protected against damage, deterioration, or loss. Section 17.4.4 of the submittal did not address the procedures to promptly detect and correct any deficiencies in managing records or implementing QA records. However, this aspect is covered in QAM Policy Q-16.1, which was previously approved by OSR and part of the authorization basis. The evaluation of the information for each review criterion is summarized below:

1. The reviewers found the identification, preparation, and maintenance of ITS records to be acceptable, as discussed in Section 3.1.2 of the QAM, Policy Q-17.1. The submittal described the review and approval of records in Section 3.7 of Policy Q-06.1.

2. The reviewers found the description of the requirement that QA records are to be legible and identifiable to be acceptable, as found in the QAM, Policy Q-17.1, Section 3.2.1. The records' retrievability over their designated lifetimes was adequately described in the QAM, Policy Q-17.1, Section 3.6.7. In addition, for computer codes or computerized data for ITS items, the PCAR, by reference to the QAM, Policy Q-17.1, Section 2, adequately described procedure(s) for maintaining readability and usability of older codes/data as computing technology changes.

3. The reviewers found acceptable the description of measures to protect against tampering, theft, loss, unauthorized access, damage, or deterioration of records for the time they are in storage, as described in Sections 3.5.3, 3.6.2, and 3.6.3 of the QAM, Policy Q-17.1.

4. The reviewers found acceptable the commitment in the QAM, Policy Q-17.1, to establish and document procedures specifying the requirements and responsibilities for selecting, verifying, protecting, transmitting, distributing, retaining, maintaining, and disposing of QA records.

5. The reviewers found acceptable the description in the QAM, Policy Q-16.1, of the organization and procedures in place to promptly detect and correct any deficiencies in managing records or implementing QA records. While this policy was not referenced in the submittal, the QAM is part of the authorization basis and was previously approved by OSR.

3.17.3 Conclusions

The reviewers concluded that the description and commitment to audits and assessments, incident report and investigations, and records management were acceptable as presented in Volume I, Section 17, of the LAW PCAR. The reviewers also concluded that the organization and administration and the CM descriptions and commitments were acceptable if BNI committed to complete the following changes:

Conditions of Acceptance – BNI must complete the following actions by the date or milestone indicated.

1. Describe organizational responsibilities and staffing interfaces for the configuration management in Section 17.4.3 of Volume I of the PCAR with the first revision of the PSAR after authorization for construction.

2. Revise procedure 24590-WTP-GPP-SIND-001-0, *Reporting Occurrences in Accordance with DOE Order 232.1A,* to address hazards and activities before the start of the pre-operational testing phase.

3.18 Fire Protection

Information concerning fire protection was not submitted for the basemat PCAR. Information in this area will be submitted with the Volume I of the PSAR and in the specific facility Preliminary Fire Hazard Analyses. The reviewers found this to be acceptable.

4.0 EVALUATION – FACILITY-SPECIFIC DESCRIPTION

As part of the PCAR, BNI submitted facility-specific information for the LAW and HLW facilities. The OSR evaluated these submittals as part of the basemat construction authorization reviews only. With future submittals, BNI will submit additional facility-specific information. The conditions of acceptance for the facility specific evaluations are contained in the text and in Appendix B.

4.1 LAW Facility

The scope of the LAW activities covered in the PCAR, Volume III, *LAW Facility Specific Information,* is construction of the LAW basemat. To accomplish this scope of construction, the following specific activities are required: installing FRE, installing the ground grid connections to LAW basemat rebar, placing the LAW basemat concrete, and backfilling the LAW basemat.

4.1.1 LAW Facility Description

The purpose of this review was to determine whether the submittal adequately described the LAW facility and processes that were encompassed by the PCAR and that could affect any safety functions, hazards, or potential accidents (at the completed facility) and their consequences. Examples of facility features are facility location, facility design information, and the location and arrangement of buildings on the facility site. Examples of process features are the general arrangement, function, and operation of major components of the processes for treating LAW.

4.1.1.1 Requirements

The requirements for the facility and process descriptions are described separately below.

Facility Description – The requirements for the LAW facility description paralleled the review criteria listed previously in Section 3.2.1 but as uniquely applied to the LAW facility. For the LAW facility basemat, the criteria included (1) facility location, (2) facility site's layout and location of buildings, (3) the facility’s ability to resist failures of ITS SSCs, (4) imposed design limits for quantifying the structural behavior of the concrete and steel structures, (5) design and analysis processes used for the ITS structures, (6) ITS electrical systems and components, (7) ventilation and air cleaning systems and components, (8) protection of control room atmospheres, and (9) effluent stacks. For the LAW PCAR, the requirements were applied only to the extent they were relevant to construction of the basemat.

Process Description – The requirements for process description are found in DOE/RL-96-0003, Section 3.3.3, "Authorization for Construction," which requires the Contractor to design the process to (1) comply with the design-related portion of the updated SRD and (2) properly account for the natural and man-made external events associated with the site. The process description was acceptable if it was presented at a level of detail appropriate to support the hazard and accident analysis, if it identified and described the features that were ITS, and if the criteria outlined below were met.

1. The basic theory of the process was generally discussed and an overview of the following were provided: operating logic, process flow diagrams, chemical formulae, reaction equations, radiolytic reactions, feed constituents, reagents, products, byproducts, effluents (solid, liquid, and gaseous), and other waste streams.

2. The general arrangement, function, and operation of major components in the process were provided.

3. Process design, materials of construction, equipment design, process control logic, and control instrumentation were discussed in sufficient detail to permit a complete understanding of the hazard and accident analyses.

4. The operating ranges and limits were provided for measured process variables (e.g., temperature, pressures, flows, and compositions) used in engineered or administrative controls as required to demonstrate adequate safety. The process operating limits and ranges were consistent with those evaluated in the hazard and accident analyses as providing adequate safety.

5. Process equipment layout in the facility was provided in schematic drawings showing plan, elevation, and isometric views of process equipment locations in the facility.

6. The process design-related codes and standards and the implementation of these codes and standards were provided.

7. Instrumentation and controls required for monitoring the process and safely shutting down the process were provided. The design also provided information on the materials selected for vessels and piping. The materials selected were consistent with the use (e.g., expected temperatures and pressures); compatible with the chemicals, reactions, and radiation fields; and meet the expected service life without exceeding corrosion and erosion allowances.[53]

[53] ASME Boiler and Pressure Vessel Code, Section UG-25, "Corrosion"; and ASME Code for Process Piping, B31.1, Section 302.4, "Allowances."

8. The facility process systems were designed to minimize the production of wastes and the mixing of radioactive and non-radioactive wastes (DOE O 420.1, Section 4.1.1.2, "Design Requirements.")

4.1.1.2 Evaluation

Results of the evaluation of facility and process descriptions for the basemat are summarized separately below.

Facility Description – The reviewers found acceptable the facility location and design descriptions provided in Sections 2, 3, and 4 of Volume III of the PCAR submittal, calculation reports, and other documents referenced in the PCAR. The reviewers found that, for the LAW basemat (includes wall connections) construction, the submittal provided acceptable information for seven criteria; two criteria were determined to be not applicable to the basemat. The evaluation of the information for each review criterion is summarized below:

1. Information on facility location was evaluated in Section 3.2.2.1 of this SER and was found to be acceptable.

2. The reviewers found the layout and location of the LAW building basemat and interfacing structural walls, as described in Section 2.3.2 of the submittal, to be acceptable and at a level of detail consistent with the preliminary level of design.

3. The reviewers found acceptable the information (Chapter 2 of the submittal) on the ability of the structural design of the basemat to resist failures of their ITS functions; these failures may be caused by credible internal and external events. The following specific evaluations were conducted:

    (a) The reviewers found acceptable the choices and specific information pertaining to required codes and standards. These codes and standards included ACI 318-99, *Building Code Requirements for Structural Concrete*; ASCE 7-98, *Minimum Design Loads for Buildings and Other Structures*; AWS D1.4, *Structural Welding Code-Reinforcing Steel*, DOE-STD-1020-94, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*; and the 1997 UBC Uniform Building Code because they met the requirements of SRD Safety Criterion 4.1-4, which is the applicable criterion for an SDS structure such as the LAW basemat.

    (b) The reviewers found acceptable the natural phenomenon hazard safety classification of the basemat and related structural elements, to ensure their safety function without failure, as seismic category (SC) III for seismic events and performance category (PC) 2 for other external events. These designations were acceptable to the reviewers because they were consistent with SRD Safety Criterion 4.1-4 and with BNI safety analyses.

(c) The reviewers found acceptable the load factors and load combinations, as found in 24590-LAW-S0C-S15T-00007, *Load Combinations*, because they were consistent with the requirements of SRD Safety Criterion 4.1-4 codes and standards, e.g., ACI 318-99 and the 1997 UBC.

(d) The reviewers found acceptable the definition of the specific loads encountered by the basemat during normal plant construction, startup, operation, and shutdown, including dead loads, live loads, thermal loads, snow loads, ashfall loads, and lateral earth pressure wind loads.[54] In response to Question LAW-PCAR-065 concerning margins of design, BNI summarized the structural evaluation results from the listed calculations by tabulating the demand/capacity ratios at several critical locations for the load combinations that controlled basemat design. The reviewers found the methods used and results of these calculations to be acceptable because all the demand/capacity ratios were less than or equal to 1.0, even though these were calculated conservatively by reducing the permissible code capacity by 15%.

(e) Creep and shrinkage forces were not addressed in Volume III of the PCAR. However, in response to Question LAW-PCAR-090 concerning shrinkage of concrete, BNI stated that many years of experience by RPP-WTP project engineers have determined that reinforced concrete structures of similar magnitude and layout configuration to the RPP-WTP facilities have not had excessive shrinkage cracking by limiting the maximum temperature of the concrete at placement to 70°F. BNI also stated that it will review construction plans and procedures to minimize any adverse effect of shrinkage through placement arrangement and sizes. In addition, construction procedures will define the length and size of concrete pours, sequence of construction, potential cooling of the aggregate, and time of placement. The basemat design complies with the minimum requirements for shrinkage reinforcement. A peer review is planned for reviewing technical specifications, construction procedures, and the batch and placement procedures. The reviewers found this response acceptable.

(f) The reviewers found acceptable the calculated loads in the basemat resulting from severe and extreme environmental conditions (i.e., a design basis earthquake), from an accidental spill of molten glass onto the basemat, and from accidental drops of heavy objects onto the basemat. The reviewers' evaluation of the seismic calculations is discussed in Section 4.1.2 of this SER.

For the accidental molten glass spill and in response to Questions LAW-PCAR-084 and -088 concerning thermal effects on the basemat, BNI proposed to provide

[54] 24590-LAW-DBC-S13T-00001, *Foundation Wall Calculations for Lateral Soil Loads*; 24590-LAW-DBC-S13T-00002, *Elevator Pit Wall Calculations for Lateral Soil Loads*; 24590-LAW-DBC-S13T-00003, *Differential Settlement in Basemat Foundations*; 24590-LAW-DBC-S13T-00005, *Thermal Analysis for Basemat and Pour Cave Walls*; 24590-LAW-S0C-S15T-00002, *LAW Floor Loading*; 24590-LAW-S0C-S15T-00005, *Wind Loads on the Building*; and 24590-LAW-S0C-S15T-00006, *Snow and Ash Load*.

sufficient additional rebar in the basemat and walls in the vicinity of the glass spill area so that the cracks that may result from the postulated accidental glass spill do not propagate to the walls, and the basemat and the walls retain their ability to support the melters, offgas system and stacks. The reviewers found the proposed design modification to support the melters to be acceptable.

To demonstrate that the basemat could perform its safety function, i.e., supporting the offgas system, the melter, and the ventilation stack, BNI provided the calculation report 24590-LAW-DBC-S13T-00014, *Basemat Analysis for Glass Spill*. This calculation showed that the basemat could withstand the thermal loads with limited damage and still perform its safety function. In the calculation, a structural analysis of the basemat and the walls was performed in the vicinity of the glass spill by assuming that a small segment of the basemat, representing the glass spill location and size, loses all its strength due to the hot glass contact. The calculation was done with a 7 x 10 ft element removed from the basemat model to represent the concrete area damaged by the glass spill. BNI concluded, and the reviewers agreed, that little effect occurred on the basemat loading and no significant change occurred to the basemat's ability to perform its safety function. The reviewers found this approach of demonstrating the structural adequacy of the basemat to support the melter, offgas system, and the stack to be acceptable.

For accidental drops of heavy objects onto the basemat, the location of the postulated drops, maximum drop heights, and the calculated severity levels to the facility worker were documented in a BNI internal memo,[55] which was included as an attachment to the basemat structural calculation report 24590-LAW-DBC-S13T-00010, *Load Drop Evaluation*. The impact to the basemat for the worst-case load drop (canister drop) was evaluated and showed that the structural damage would be acceptable. Considering that no local functional safety requirements (confinement criteria) were required for the basemat, the reviewers found the load drop analysis to be acceptable.

4. The reviewers found acceptable the structural demands and strength capacities for each combination of factored loads for the LAW basemat, as provided in calculation reports 24590-LAW-DBC-S13T-00009, *Foundation Basemat Design*, and 24590-LAW-DBC-S13T-00011, *Basemat Wall Design*. These calculations provided the detailed design of rebar necessary to meet the ACI 318-99 code strength requirements. The reviewers assessed the calculations specifically for required strength for each load combination; use of strength reduction factors for each design strength for flexure, compression, shear, and tension; methods of determining controlling stress locations; minimum size and thickness requirements; rebar design and placement; rebar splice and embedment; and conservative factors to offset inaccuracies in computer model discretization and simplifying analysis approximations. The reviewers found the methods and calculations to be acceptable because they were consistent with DOE-STD-1020-94 and other applicable codes and all

[55] CCN: 023642, internal BNI memo, J. Hinckley to S. Thomson, "Load Drop Scenario for LAW," dated September 28, 2001.

the demand/capacity ratios presented were equal to or less than 1.0, even though these were calculated conservatively by reducing the permissible code capacity by 15%.

5. The reviewers found the design and analysis processes used for the basemat to be acceptable as noted in the following specific evaluations:

   (a) The computer program GTSTRUDL was used for performing structural analysis of the LAW building, including the basemat. The reviewers found the description of the computer code GTSTRUDL validation and verification in Section 2.4.8 of the submittal to be acceptable because it was performed by using sample verification problems.

   (b) The reviewers found the finite element model of the LAW building and the resulting demands to be acceptable. Calculation report 24590-LAW-S0C-S15T-00001, *GTSTRUDL Finite Element Analysis Model,* was evaluated for the reasonableness of assumptions and results from the design and analysis process. In response to Question LAW-PCAR-093 concerning adequacy of the model discretization and the representation of soil pressure loads under the basemat, BNI performed additional calculations, CCN 031866,[56] and developed a method for ensuring that the demands (moments and shears) predicted by the GTSTRUDL model were appropriate.

   (c) The reviewers found the calculation reports 24590-LAW-DDC-S13T-00001, -00003, and -00006, *LAW Pour Cave Carousel Embedment Capacity, C3/C5 Drain Tank Embedment Analysis, and C1/C2 Drain Tank Support Design,* respectively, to be acceptable design and analysis processes because the loads, design/analysis methods, and capacities used were consistent with Portland Cement Association code PCA EB 080, *Strength Design of Anchorage to Concrete,* DOE-STD-1020-94, and the applicable implementing codes and standards of SRD Safety Criterion 4.1-4.

   (d) The reviewers found acceptable the treatment of stress reversal from seismic loads in LAW building seismic calculations and in the basemat design calculation report 24590-LAW-DBC-S13T-00009. Stress reversal from seismic loads was adequately accounted for in the load combination calculations.

   (e) The reviewers found the treatment of localized and transient structural loads in designing and analyzing the basemat to be acceptable based on the method described in 5(b) above.

   (f) The PCAR did not discuss the effects of various construction inspection levels on the design strength of the concrete and the construction methods used to guard against concrete cracking due to shrinkage and other volume changes. However,

[56] CCN: 031866, letter, M. Scott, BNI, to D. Houghton, BNI, "Responses to LAW Preliminary Construction Authorization," dated April 10, 2002.

in response to Question LAW-PCAR-090 concerning this issue, BNI provided a plan to guard against this cracking as discussed previously in item 3(e) above. The reviewers found this approach to be acceptable.

6. The PCAR did not provide information on electrical components or electrical system design relative to the basemat and walls because none was needed for concrete basemat structural design (see Section 3.2.2, Item 6, of this SER). The reviewers agreed that this information was not relevant to the basemat's structural design. The reviewers evaluated the information submitted on the electrical grounding system. The reviewers found the description of the electrical grounding system to be consistent with the industry standards for electrical grounding systems. The PCAR commited to designing and analyzing the electrical grounding system per IEEE Standard 142, *Recommended Practice for Grounding of Industrial and Commercial Power Systems* and NFPA 70, Article 250. In the Limited Construction Authorization Request (LCAR) (Section 1.3.2.3), BNI provided a general description of the functions of the electrical grounding system. The LCAR stated that electrical equipment was connected to the grounding system to provide personnel and equipment protection for an electrical fault, but connection to the grounding grid was not required for operation of the electrical equipment. The LCAR further stated that degradation and malfunction of the grounding system would not impact the functionality of the ITS electrical equipment, and concluded that, the electrical grounding system was not ITS. The reviewers agreed that the electrical grounding system was not ITS, and had no potential to adversely impact ITS structures, systems, or components. On this basis, the reviewers concluded that construction of the grounding grid was acceptable, and should be authorized.

7. Information on ventilation and air cleaning systems relevant to the structural design of basemat and interfacing walls was contained in calculation 24590-LAW-RPT-HV-01-002, *Thermal/Ventilation Modeling for LAW Pour Cave and Turn Table Based on Computational Fluid Dynamics Study.* The calculation included the thermal flow Computational Fluid Dynamics (CFD model) and temperature limitations of the basemat and walls. This information was found to be acceptable.

8. The PCAR did not provide information on protecting control room atmospheres because it was not considered relevant to design of the LAW basemat. The reviewers agreed.

9. The PCAR did not provide information on the effluent stack in the submittal because BNI did not consider it to be relevant to the basemat's overall structural design. While the LAW stack was included in the GTSTRUDL structural model, no calculations were available for evaluating the strength of the LAW stack. The adequacy of the stack to withstand NPH events and off-normal conditions that may arise during plant operation will be assessed during the LAW PSAR review. However, regarding the basemat design adequacy relevant to the basemat's ability to perform its safety function, i.e., supporting the C5 ventilation system, the melter, and the ventilation stack, BNI provided additional information in response to Questions LAW-PCAR-084 and -088 concerning the thermal impact of a glass spill onto the basemat. In addition, calculation report 24590-LAW-DBC-S13T-00014 was provided and showed that the basemat could withstand the

thermal loads while performing its safety function. This was discussed previously in SER Section 4.1.1.2, Item 3(f). This response was acceptable to the reviewers.

Process Description – In the discussion of process description in the PCAR, the reviewers found five of the eight criteria to be acceptably met and the remaining three criteria not to be applicable to the basemat. The review was limited to ITS components that had a potential impact to the basemat. The evaluation of the information for each review criterion is summarized below:

1. The reviewers found acceptable the discussion of the basic theory of the process, the overview of the operating logic, process flow diagrams, chemical formulae, reaction equations, radiolytic reactions, feed constituents, reagents, products, byproducts, effluents and other waste streams. An overview of the process description for the LAW was provided in Section 2.3.1 of Volume III of the PCAR, along with Figure 2-8. In response to Question LAW-PCAR-098 concerning the possibility of mis-feed of HLW from PT to LAW, BNI selected an additional control in the LAW facility. The wet process cell walls will provide shielding to protect workers in the event of a mis-feed of HLW to the LAW facility. The reviewers found this response acceptable.

2. The reviewers found acceptable the general arrangement, function, and operation of major components for the process as described in Section 2.5 of the submittal because all major ITS components relative to the basemat had been addressed.

3. The reviewers found the process design, materials of construction, equipment design, process control logic, and control instrumentation to be acceptable and consistent with requirements of the SRD, with the exception of the mis-feed from PT already discussed.

4. The reviewers found the operating ranges and limits of measured process variables as related to the basemat to be acceptable and consistent with those evaluated in the hazard and accident analyses, with the exception of the mis-feed from PT already discussed.

5. The reviewers found the information on process equipment layout in the facility as related to the basemat to be acceptable. Schematic drawings of the layout, in Figures 2-5, 2-6, and 2-7, provided sufficient information to meet basemat design requirements.

6. The reviewers found the description of process-related codes and standards to be used with the basemat to be acceptable because it met the requirements of SRD Safety Criterion 4.1-2.

7. Instrumentation and controls for monitoring and safely shutting down the process were evaluated. The review found the instrumentation and controls associated with the safety functions of the basemat were acceptable. Additional information on instrumentation and controls for monitoring the process will be provided with the LAW PSAR.

8. Design of the facility process systems to minimize the production of wastes was not considered part of the review scope for basemat and therefore was not evaluated.

Information on waste minimization and the solid waste-handling system will be provided with the LAW PSAR.

4.1.1.3 Conclusions

The conclusions for the facility and process descriptions are presented separately below.

Facility Description – The reviewers concluded that the requirements of the facility description for the PCAR as related to construction of the LAW basemat had been met. The facility description was adequate to support the hazard and accident analysis for the LAW basemat.

Process Description – The reviewers concluded that the PCAR met evaluation criteria for the process description portion for the PCAR as related to the basemat. The submittal adequately described the processes that could affect safety functions of the LAW facility basemat.

4.1.2 LAW Facility Hazard and Accident Analysis

The purpose of this review was to determine whether the submittal adequately described the hazard and accident analyses performed for the LAW basemat and whether the analyses complied with the SRD and ISMP. The review also determined whether the analyses performed will result in or enable the LAW facility design, construction, facility operation, maintenance, and deactivation to protect the health and safety of the workers, the public, and the environment. This review was specific to Volume III, *LAW Facility Specific Information*, of the submittal as it related to hazard and accident analysis for the LAW basemat.

4.1.2.1 Requirements

According to the SRD, Volume II, Appendix A, Section 4.0, "Hazard Evaluation," the following nine elements of hazard and accident analyses for the basemat should be evaluated:
(1) identifying hazards; (2) identifying potential accident/event sequences; (3) estimating accident consequences; (4) estimating accident frequencies; (5) considering common-cause and common-mode failures; (6) defining DBEs; (7) defining the operating environment;
(8) identifying potential control strategies; and (9) documenting the hazard and accident evaluation. In addition, the identification of assumptions and analysis of uncertainty should be evaluated.

For internal DBEs, the evaluation for the basemat should assess the identification and analysis of internal DBEs that are affected by the basemat design. For external DBEs, the evaluation should assess selection of the seismic and other external events for the basemat, including the seismic design criteria.[57] Facility preliminary seismic analyses should be evaluated to ensure that the

[57] RL/REG-99-05, Section 4.6, "External DBEs."

preliminary basemat design would meet applicable requirements for load when subjected to the design-basis earthquake. Consistent with the design's preliminary level, the evaluation should assess the chemical process safety of the basemat design and whether the submittal had adequately identified and analyzed potential chemical hazards and accidents associated with the basemat.

4.1.2.2 Evaluation

The reviewers evaluated information provided in Section 3, "Hazard and Accident Analysis" and in Appendix A, "LAW Hazards Assessment Report," of the submittal against the applicable criteria defined in the SRD and in RL/REG-99-05. Relevant references in the submittal were also reviewed to assess the scope, breath, and depth of the detailed information underlying the discussion and to determine the completeness and accuracy of the information in supporting the conclusions. These references were also reviewed to determine the implementation and documentation of the ISM process as it applied to the LAW hazards and accident analysis results. These references included calculations, studies, drawings, system notebooks, additional detailed printouts from the SIPD database, system description reports, and other relevant supporting documentation.

In response to Question LAW-PCAR-047 concerning basemat accidents, BNI stated that accidents were considered basemat related if the event could compromise the basemat's ability to fulfill its safety function. These events included radioactive spills onto the basemat with consequences beyond severity level (SL) 4, energetic events such as glass spills or canister drops onto the basemat, spills of corrosive chemicals onto the basemat, and seismic events. The reviewers found this response to be acceptable.

The evaluation of the information for each review criteria is summarized below. The reviewers found the submittal acceptably met seven of the nine criteria and conditionally met two of the criteria:

1. **Identifying Hazards** – The reviewers found the identification of hazards to be conditionally acceptable, as described in Section 3.3.2 of the PCAR; the CSD records in Appendix A; and the hazard analysis results in BNI report 24590-WTP-RPT-TE-01-004, *Design Basis Event Selection for the Low Activity Waste Vitrification Facility*. The reviewers also evaluated BNI responses to Questions LAW-PCAR-008, -013, -018, and -049, which clarified the hazard analysis results. The reviewers evaluated this information against acceptance criteria in RL/REG 99-05, Section 4.4.3.3, item 1.

   For the basemat, the PCAR provided a sufficiently complete list of chemical and radiological hazards, potential consequences, possible causes, and estimated frequencies in Appendix A of its submittal. The reviewers concluded that the PCAR adequately described the hazardous situations applicable to the basemat and provided the information necessary to conduct thorough and accurate accident analyses to define DBEs and hazard control strategies for the basemat. The information provided, as supplemented by information in responses to the reviewers' questions and in reviewed calculations, was consistent with the current status of the facility and process design. The reviewers identified numerous discrepancies concerning the CSD record identification system used in SIPD and as referenced in the LAW PCAR text and tables, its hazard assessment report table (Appendix A), associated calculations, and drawings. The identification system of components had similar discrepancies. Individual components may have different IDs as referenced in the LAW PCAR text, figures, drawings, and CSD records. This situation initially created uncertainty in understanding hazards and identifying important components and increased the difficulty to cross reference or check hazardous situations described in CSD records in different LAW documentation. The same discrepancies apply to the HLW PCAR. To correct this, the safety documentation for the LAW and HLW facilities must be updated for all CSD and component ID references in the PSAR and in its references, from the old system to the new system. This is a condition of acceptance for this criterion and must be completed in the next revision to the LAW and HLW PSARs.

Appendix A of the LAW PCAR contained only the CSD records for hazards that have the potential to produce unmitigated radiological consequences above SL-4 and chemical consequences above threshold, i.e., CSD records for SL-1, -2 and -3 events. In response to OSR question LAW-PCAR-049, BNI stated that the complete listing of all hazards, including SL-4 hazards, were in 24590-WTP-RPT-TE-01-004 and that the PCAR only reported SL-1, -2, and -3 hazards. The reviewers found this to be acceptable.

Because of the LAW facility's low radiological source term, the LAW facility was categorized Hazard Category 3 using DOE-STD-1027-92, *Hazard Categorization, and Accident Analysis Techniques for Compliance with DOE Order 5480.23*, *Nuclear Safety Analysis Reports*. The reviewers evaluated the basis for this categorization (24590-LAW-Z0C-U10T-00001, *Hazards Categorization for LAW*) and found it to be acceptable.

The PCAR identified potential hazards for the basemat in CSD records in Appendix A of the LAW PCAR, including their potential consequences, possible causes, and estimated initiating frequencies. Based on reviewer questions, BNI also evaluated hazards from a molten glass spill from the melter (Questions LAW-PCAR-039, -040, -043, -052, -055, -89, and -88) and elaborated on hazards and controls associated with the mis-feed event (LAW-PCAR-098, -014, -051, -058, and -099).

Based on LAW processes, design, and operations and analyses using the ISM process, BNI also systematically developed and compiled a list of hazardous materials and energy sources associated with the basemat. These results for the basemat were documented in Sections 3.3.2.1 and 3.3.2.2 and Appendix A of the PCAR.

One radiological situation involving a liquid spill/overflow from the LAW Concentrate Receipt vessel (CSD-LLCP/N0002) potentially resulted in an unmitigated dose of 5 rem to a facility worker (SL-2). For chemical hazards, the PCAR identified several hazardous situations that could lead to unmitigated chemical exposures above threshold. SRD

Safety Criterion 2.0-2 defines these as events that could reasonably be expected to result in a fatality or in-patient hospitalization of three or more individuals, co-located workers, and the public. However, only the potential chemical accidents involving the release of untreated melter offgas into the facility, CSD-LLOP/N0001, had the potential to lead to unmitigated consequences above the chemical exposure standards of SRD Safety Criterion 2.0-2 for the co-located worker. No chemical releases were postulated to be above threshold for the public.

LAW facility ITS SSCs (primary and secondary offgas system, piping and stack, and melter shell) were not located on the basemat; however, their safety function depended on the basemat's structural capability. The principal related hazards were a seismic event or a molten glass spill. Other hazards considered were canister drops, liquid spills, and leaks and overflows form tanks. The LAW structure supports the melters, exhaust stack, and offgas confinement systems during normal, abnormal, and accident conditions.

The reviewers determined that the identification of radiological hazards, including those found in Section 3.3.2 of the PCAR, was acceptable if the analysis related to the mis-feed hazardous situation (Question LAW-PCAR-098) is incorporated into the next PSAR revision. The reviewers also found the evaluation of identified chemical hazards to be conditionally acceptable based on conclusions from calculation CCN 031866,[58] which addressed issues associated with a molten glass spill event. The mis-feed and molten glass spill events and associated conditions are discussed further below. The reviewers found that the identification of hazards satisfied the requirements of SRD Safety Criteria 3.1-1 and 9.1-7; the SRD, Appendix A, Section 3.0, "Identification of Work"; and the SRD, Section 4.1, "Identification of Hazards."

The reviewers identified and resolved issues concerning two significant hazards associated with the adequacy of the basemat design. The first concerned the possible hazards of a mis-feed of HLW tank waste directly from the PT facility to the LAW facility. In such an event, the radionuclide or hazardous chemical content in the feed could be higher than analyzed in the facility design. The reviewers asked BNI to clarify the hazards associated with the mis-feed event (e.g., Questions LAW-PCAR-098, -014, -051, -058, and -099). The reviewers requested that BNI address the requirements of SRD Safety Criteria 3.1-3 and 3.1-4 and the SRD, Appendix A, Section 4, to perform the hazard analysis to determine the consequences and frequency of unmitigated releases of radioactive material and process chemicals resulting from the mis-feed event. In response to Question LAW-PCAR-098 concerning LAW feed inventories, BNI stated that the unmitigated consequences of this event were SL-1 to the facility worker and identified suitable controls at the PT facility for preventing the mis-feed and controls in the LAW facility to mitigate the event if it were to occur.

The second issue concerned the hazards of thermal impacts of a glass spill onto the concrete basemat. The reviewers questioned the impacts of a molten glass spill onto the

[58] CCN: 031866, letter, M. Scott, BNI, to D. Houghton, BNI, "Responses to LAW Preliminary Construction Authorization," dated April 10, 2002.

basemat (Questions LAW-PCAR-039, -040, -043, -052, -055, -84, and -88). The questions focused on determining the bounding thermal impacts of the glass spill on the concrete and the SSCs required to mitigate the thermal effects of the spill to the basemat, if any. In response, BNI stated that they had performed additional thermal and structural calculations (CCN 031866[59] and 24590-LAW-DBC-S13T-00005, *Thermal Analysis for Basemat and Pour Cave Walls*) to identify the bounding thermal effects. The calculations found that the glass spill did not affect the overall structural integrity of the LAW basemat structure (when redesigned to consider such thermal effects) and therefore did not impair the basemat's ability to perform its safety function(s). The submittal stated that the basemat's ITS function was to provide structural support of both the offgas system and the ventilation stack, such that there would be confinement by the offgas system piping and unimpeded flow within the offgas system. Any local damage that might occur in the pour cave located on the basemat (under the melter) as a result of a glass spill did not affect the structure's stability or its ability to structurally support these ITS systems. The ventilation stack and offgas system also were routed away from the pour caves.

The reviewers found these calculations (CCN 031866 and 24590-LAW-DBC-S13T-00005) to be conditionally acceptable, except for the temperature assumptions used in CCN 031866. In the bounding scenario, the pour cave wall cooling panels were assumed to not be operating. However CCN 031866 assumed cooling panels on the pour cave walls were operating. In response to Question LAW-PCAR-039 concerning this inconsistency, BNI committed to confirm, using computational fluid dynamics analysis, that the concrete temperatures of the melter and pour caves could be maintained within design limits during a postulated loss of cooling accident scenario. This analysis will be consistent with the cave cooling assumptions made in the accident scenario and will be completed before and in support of the LAW PSAR as a condition of acceptance. All structural calculations affected by the computational fluid dynamics analysis will be revised, as appropriate, if required. This must be completed before authorization of full facility construction as a condition of acceptance.

2. **Identifying Potential Accident/Event Sequences** – The reviewers found the identification of potential accident/event sequences to be acceptable, as described in Chapter 3, CSD records in Appendix A of the LAW PCAR, and 24590-WTP-RPT-TE-01-004. Sections 3.3.1, 3.3.2, and 3.3.3 described the identification of internal and external generated events. The reviewers evaluated this information against acceptance criteria in RL/REG 99-05, Section 4.4.3.3, item 2. The information satisfied the requirements in SRD Safety Criterion 3.2-1; the SRD, Appendix A, Section 4.2, "Identification of Potential Accident/Event Sequences"; and the ISMP, Section 1.3.6, "Accident Analysis."

   The reviewers found the limited reference on the evaluation of secondary events directly caused by external events (such as hazards from other facilities, aircraft crashes, pipeline

[59] CCN: 031866, letter, M. Scott, BNI, to D. Houghton, BNI, "Responses to LAW Preliminary Construction Authorization," dated April 10, 2002.

ruptures, and truck crashes) to be acceptable because they were judged not to affect the basemat design requirements. Additional information specific to an aircraft crash was provided in response to Question LAW-PCAR-068 and with respect to a mis-feed event in CSD-L100/0076 and in response to Question LAW-PCAR-068. The reviewers found this acceptable because it complied with RL/REG-99-05 guidance for the basemat analysis.

For internal events, the PCAR identified internal event sequences involving liquid spills or overflows from SSCs located on the basemat; however, these event sequences did not affect or impose design requirements on the basemat. The PCAR also analyzed internal event sequences leading to molten glass spills on the basemat from the melter. For external events, the PCAR identified two external event sequences that could impact the basemat: (1) the seismic DBE and (2) the mis-feed event. The identification of these were found to be acceptable because the results were analyzed using a systematic and comprehensive approach that satisfied the requirements in SRD Safety Criteria 3.2-1 and the SRD, Appendix A, Section 4.2.

For potential event sequences that could lead to unmitigated consequences of SL-1, -2, and -3 or above chemical thresholds, the PCAR sufficiently described these potential event sequences (e.g., glass spill event, seismic DBE, mis-feed event, and spill/overflow events from the LAW concentrate receipt vessel) to estimate the unmitigated consequences and frequencies.

In response to Question LAW-PCAR-020, BNI described the process used to bin the accidents to select DBEs. A combination of control strategy, consequence and accident type was used to select accidents. The reviewers found that the binning approach used was comprehensive and complete, as related to the basemat.

The reviewers found that Chapter 3 of the PCAR and Appendix A, along with the referenced calculations (see Section 8.0), provided (a) accident sequences that identified initiating events with their prevention and mitigation measures and other contributing phenomena, (b) rationale for sorting hazardous situations into accident groups or categories and (c) selection of accident sequences that were comprehensive and credible.

3. **Estimating Accident Consequences** – The reviewers found the PCAR estimation of accident consequences to be acceptable, as described in Chapter 3 of the PCAR, CSD records in Appendix A, 24590-WTP-RPT-TE-01-004, and 24590-LAW-Z0C-W14T-0003, *Revised Severity Level Calculations for the LAW Facility*. Sections 3.3.3 and 3.3.5 provided the results of unmitigated and mitigated consequence analysis for the potential accident/event sequences impacting the basemat. The reviewers evaluated this information against acceptance criteria in Item 3 of Section 4.4.3.3 in RL/REG 99-05. These are discussed below:

   (a) **Unmitigated Consequences** – The submittal provided estimates of the accident consequences. For basemat-affecting hazardous situations, the PCAR identified in the CSD record section (Appendix A) the potential radiological and chemical hazard consequences for facility and co-located workers and the public for radiological consequences above SL-4 and chemical consequences above threshold.

In regard to radiological consequences, Section 3.4.2 of the submittal described two external events, the seismic event and the mis-feed event. For the seismic DBE, calculation report 24590-LAW-Z0C-S30T-00001 provided the unmitigated and mitigated accident consequences. The calculation estimated that the largest unmitigated radiological dose to the facility worker during a seismic event (5.1 rem) was below the radiological exposure standards limit for mitigated dose for an unlikely event (25 rem). The cumulative unmitigated inhalation doses for the co-located worker (<10.5 rem) and the public (<20 mrem) based on the failure of all vessels containing radioactive material were similarly below the radiological exposure standards limits for a mitigated dose for an unlikely event (25 rem for the public and co-located worker).

For the seismic event, BNI determined that unmitigated consequences from offgas and glass spills from three catastrophically failed melters would be 4.5 rem to the co-located worker and 1.42×10^{-2} rem to the public (24590-LAW-Z0C-S30T-00001). The unmitigated dose to the worker from offgas and glass spill from one catastrophically failed melter was estimated to be 1.07×10^{-2} rem.
For the mis-feed event where high activity material could be transferred from the PT facility to the LAW facility, PCAR Section 3.4.2.2 stated that unmitigated area radiation levels could be as high as 100 mrem/hr. However, a revised analysis of this event was documented in the LAW PSAR and in the response to Question LAW-PCAR-098. The question response and the LAW facility PSAR identified that unmitigated consequences from a mis-feed event could result in exposures to the facility worker of >25 rem, an SL-1 event. The scenario assumed Waste Envelope B/D was inadvertently transferred from PT to LAW while a facility worker was in the wet process cell.

As noted previously in Item 1, "Identifying Hazards," one other radiological hazardous situation involving a liquid spill/overflow from the LAW Concentrate Receipt vessel, CSD-LLCP/N0002, potentially resulted in an unmitigated dose of 5 rem to a facility worker (SL-2).

Finally, Section 3.3.3 of the PCAR estimated that unmitigated chemical releases from a loss of the offgas system event (CSD-L720/0001) could lead to chemical consequences above threshold.

(b) **Mitigated Accident Consequences** – For the seismic event, calculation report 24590-LAW-Z0C-S30T-00001 was performed to determine the appropriate seismic classification of the LAW facility, which was SC-III on the basis of chemical consequences. Because the facility was designed to appropriate seismic criteria basis, no mitigated radiological or chemical consequences resulted from the design seismic event. Reviewers found this to be acceptable.

For the molten glass spill, there were no mitigated consequences because the basemat's safety function was shown to be unaffected by the molten glass spill, as analyzed in CCN 031866.[60]

For the mis-feed event, if the preventive control strategies were to fail, the mitigated exposure to the facility worker would be several hundred mrem, meeting the radiation exposure standards of SRD Safety Criterion 2.0-1 for all frequency ranges.

For the liquid spill/overflow event, the submittal stated that there were no mitigated consequences because of the administrative controls to be implemented to prevent the event. The submittal specifically stated that controls were adequate to prevent this event because (1) although access is permitted in the wet process cell that contains the concentrate receipt vessel, no personnel access is allowed when the concentrate receipt vessel contains LAW concentrate; (2) access would be permitted only after draining and flushing the vessels to reduce the radiation levels to those low enough for personnel access; and (3) personnel access to the wet process cell will be controlled by a locked (key) door based on Radiation Protection Program requirements.

The reviewers concluded that the administrative controls were adequate to prevent a dose to a facility worker. The reviewers considered that because this event was just severe enough to be in the SL-2 category and the administrative controls committed to appear robust and commensurate with the limited hazard, controls were acceptable in this case (in lieu of engineered controls) to protect the facility worker.

For the loss of offgas release (CSD-L720/0001), there were no mitigated consequences because the event was prevented by the design of the offgas system to meet the single failure criterion as defined in SRD Safety Criterion 4.3-2.

The reviewers found the PCAR estimates of unmitigated consequences for radiological and chemical hazardous situations to be acceptable. The reviewers also found the mitigated consequences for the identified accident sequences and associated CSD records to be acceptable. The reviewers found these results satisfy the requirements of SRD Safety Criteria 3.1-3 and 3.1-4, and SRD Appendix A, Section 4.3, "Estimation of Consequences."

4. **Estimating Accident Frequencies** – The reviewers found the PCAR estimate of accident frequencies to be acceptable because it provided sufficient bases to estimate accident frequencies. The reviewers found that the Appendix A records contained acceptable estimates of the frequency of accident initiators. The estimation of accident frequencies relevant to the basemat were documented in Chapter 3, the CSD records in Appendix A,

[60] CCN: 031866, letter, M. Scott, BNI, to D. Houghton, BNI, "Responses to LAW Preliminary Construction Authorization," dated April 10, 2002

and hazard analysis in 24590-WTP-RPT-TE-01-004. These frequency determinations were based on methodology described in 24590-WTP-GPP-SANA-002. The reviewers evaluated this information against acceptance criteria in RL/REG 99-05, Section 4.4.3.3, Item 4, as discussed below.

The estimates of initiating event frequencies in CSD records and mitigated accident frequencies were provided in DBE calculation reports, 24590-LAW-Z0C-W14T-0003 and 24590-LAW-Z0C-S30T-00001. The reviewers evaluated the CSD records for initiating event frequencies and assessed Section 3.3.3 of the submittal, which indicated that radiological and chemical events were conservatively assigned an initiating event frequency that placed them in the unlikely event frequency bin unless the event initiator was an earthquake. The highest frequency of this unlikely event range, 0.01 events per year, was selected consistent with the highest failure rate for process vessels and piping recommended by 24590-WTP-GPG-SANA-002. The reviewers found these values to be acceptable because they were consistent with data from other industrial sources, such as AIChE *Guidelines for Process Equipment Reliability Data, with Data Tables,* and represented the mean value from these data sources.

Section 3.4.2 of the submittal described two external events and their estimated event frequencies, the seismic DBE and the mis-feed event. For the seismic DBE, the annual probability of occurrence of the SC-III design basis earthquake was 10^{-3}. In the response to Question LAW-PCAR-098, BNI stated that for the mis-feed event, the estimated probability of occurrence was not credible for a "significant exposure" based on several independent controls that prevent the mis-feed event (gamma monitors and associated interlocks, administrative controls for valve and jumper line-up, and vessel sampling). While BNI did not provide an explicit basis for the estimated probability of occurrence or the level of exposure considered "significant," the reviewers agreed that controls committed to be provided in the PT facility, in conjunction with the shielding provided by the LAW facility process cell walls, adequately protect the workers.

Appendix A of the PCAR identified numerous initiators leading to a molten glass spill event, with estimated frequencies of 10^{-2}/year. In the operational risk assessment, 24590-WTP-U7C-50-00001, *WTP Risk Analysis – Risk Goal Confirmation, Volumes 1-5*, the potential failure rates of glass melter shells and other similar vessels were estimated to be 10^{-3} to 10^{-2}/year.

Concerning the liquid spill event (CSD-LLCP/N0002) discussed above, the estimated frequency of failure of the administrative controls was 5×10^{-3}/yr. The reviewers found this estimate to be acceptable.

5. **Considering Common-Cause and Common-Mode Failures –** The reviewers found acceptable the consideration of common-cause and common-mode failures as described in Section 3.3.4 and the CSD records in Appendix A of the submittal, the hazard analysis 24590-WTP-RPT-TE-01-004, and referenced DBE calculations. The reviewers evaluated the information against acceptance criteria in RL/REG-99-05, Section 4.4.3.3, Item 5. Credible common-cause events that could affect the basemat included natural

phenomena events, external man-made events, loss of electrical power, fire, internal missiles and internal flooding.

Section 3.3.4 of the PCAR described three broad categories of dependencies used to classify and define the important common-cause failures. The PCAR addressed two of these, functional dependencies and spatial dependencies, and deferred consideration of institutional dependencies until a later PSAR submittal when the plant maintenance, operations, and procurement activities become more developed. The PCAR stated that the basemat was not functionally dependent on active SSCs because the basemat had a passive safety function. The reviewers agreed the deferral of institutional dependencies was acceptable because these can be addressed in the programmatic development of the maintenance, operations, and procurement programs.

The Appendix A records documented the hazards associated with the potential for human error and external events that could initiate credible common-mode failures. The records also considered and identified credible common-mode failures from failures of dependent subsystems (functional dependencies) and from failures of SSCs whose functional capabilities the systems depend on (i.e. electrical power) through dependent failure modeling.

The PCAR stated that the passive safety function of the basemat was not impacted by internal events such as fires or flooding. The reviewers found this approach acceptable for the basemat because of the facility's low combustible loadings. For internal flooding, the reviewers found that structural loads to the basemat from internal flooding had not been considered. The reviewers assessed that internal flood loads, if any, would not sufficiently impact the basemat to prevent it from performing its intended safety function (i.e., structural support to the offgas system, associated piping, and the stack). The LAW basemat was not expected to be impacted because it is five feet thick and the interior walls are less than four feet thick. The reviewers concluded that the maximum moment due to flooding that can be transferred from the wall is not expected to exceed the basemat's capacity.

The reviewers found the consideration of common-cause and common-mode failures using functional and spatial dependency analysis to be acceptable for the basemat. The reviewers also found that the information regarding common cause/common mode satisfied the requirements of the SRD, Appendix A, Section 4.5, "Consideration of Common Cause/Common Mode Failures."

6. **Defining DBEs** – The reviewers evaluated both internal and external DBEs affecting the basemat.

   (a) **Internal DBEs** – For internal DBEs, the reviewers found that BNI's selection of internal DBEs effectively defined the bounding hazard control strategies for the basemat. Based on the DBE selection analysis in Sections 3.3 and 3.4 and Appendix A of the PCAR and in 24590-WTP-RPT-TE-01-004, BNI concluded that only one internal DBE could potentially be affected by the basemat: offgas release of NO_x from the melter into LAW facility or into the environment. This NO_x release would result from the loss of structural capability of the facility, to the extent that the offgas system, piping, and its stack lost confinement integrity or unimpeded flow capability. The PCAR stated that the design basis offgas release event was initiated by a design basis (external) seismic event.

The reviewers questioned the impact of a molten glass spill event and its impact on the basemat's structural capability (Questions LAW-PCAR-039, -040, -43, -052, -055, -84, and -88). BNI performed unmitigated analyses of the thermal impact of the hot molten glass spilling onto the concrete basemat floor to determine its potential damage to the basemat and whether such an event would affect the basemat's ability to perform its intended safety function. BNI performed thermal and structural analyses (calculations 24590-LAW-DBC-S13T-00005 and CCN 031866[61]) to address these impacts and modified the structural design accordingly. These calculations were reviewed and found to be acceptable based on the inputs, assumptions and methodology used.

The submittal did not explicitly discuss fire-related DBEs. However, 24590-WTP-RPT-TE-01-004 and Appendix A of the PCAR identified a potential fire (CSD-LLVP/N0001) that could disable the offgas system, causing a chemical release event with above-threshold consequences for the co-located and facility worker. The submittal indicated that internal fires were considered part of the common- cause and common-mode failure analysis. The submittal noted that fires do not impact the basemat's passive safety function. The reviewers found this to be acceptable based on the basemat's low fire hazard and considering that a fire would not impair the basemat's safety function.

(b) **External DBEs** – The reviewers found the selection and analysis of external DBEs that affect the basemat (Section 2.4.2 in the submittal) to be acceptable according to the acceptance criteria in RL/REG 99-05, Section 4.6.3. Based on the DBE selection analysis (24590-WTP-RPT-01-004), BNI concluded that only two external DBEs could potentially affect the basemat: the seismic DBE and the mis-feed event.

For seismic and other external DBEs, the reviewers evaluated calculations, design information in the PCAR, and the responses to Questions LAW-PCAR-066 to -077, -079 to -089, and -091 to -097 concerning basemat design and analysis, including interfacing walls that transfer vertical loads to the basemat. The reviewers also evaluated this information for other external facility phenomena and events (e.g., wind, missiles due to wind, flooding, volcanic ash, and snow and mis-feed). The reviewers found the information to be acceptable per the eight information areas identified in RL/REG-99-05, Section 4.6.3.3.1, for seismic DBEs. Evaluation of the information for the seismic DBEs for each of the eight

[61] CCN: 031866, letter, M. Scott, BNI, to D. Houghton, BNI, "Responses to LAW Preliminary Construction Authorization," dated April 10, 2002.

information areas is summarized below:

(i) The reviewers found the LAW facility-specific submittal's identification of the basemat and interfacing structure as SC-III and PC-2 to be acceptable because they were consistent with SRD Safety Criterion 4.1-4 requirements.

(ii) The reviewers found the seismic hazard curve and response spectra for PC-2 and the LAW facility to be acceptable because they were consistent with SRD Safety Criterion 4.1-4 and DOE-STD-1020-94 requirements.

(iii) The reviewers found the seismic analysis methods provided in calculation reports 24590-LAW-S0C-S15T-00003, *Spring Base Static Analysis*, and 24590-LAW-S0C-S15T-00004, *Fixed Base Dynamic Model*, to be acceptable based on the response to Question LAW-PCAR-093 and the review of CCN 031866. Use of the static base analysis and UBC formulas were found to be acceptable because they were consistent with SRD Safety Criterion 4.1-4 and DOE-STD-1020-94. The earthquake loads directional combination method was found to be acceptable. The reviewers found the treatment of torsional effects and determination of structure overturning moments and design margins[62] to be acceptable.

(iv) The reviewers evaluated the seismic analysis calculation report (24590-LAW-Z0C-S30T-00001), including models, methods, element seismic demands, factored and combined total element structural demands and comparison to reinforced concrete element structural capacities, rebar design details, and design margins for structural design adequacy. The reviewers found the interpretation of acceptance criteria to be acceptable, including the process to compare the calculated seismic and total demands with the corresponding capacities. The reviewers found the seismic design analyses to be acceptable because they used the provisions of the ACI 318-99 concrete code, which were consistent with SRD Safety Criterion 4.1-4 and the DOE-STD-1020-94 requirements per the SRD.

(v) The reviewers found the detailing requirements for anchoring the reinforcement bars in the reinforced concrete design of the LAW PC-2 basemat and calculations for anchoring selected major components by embedments in the basemat to be acceptable because they were consistent with the ACI 318-99 concrete code; the Portland Cement Association standard PCA EB 080, and DOE-STD-1020-94 requirements.

[62] CCN: 024490, letter, A.R. Veirup, BNI, to M.K. Barrett, ORP, "Contract No. DE-AC27-01-RV14136 – Request for Review and Approval of the Partial Construction Authorization Request for the Hanford Tank Waste Treatment and Immobilization Plant," Attachment 2, "Activity Descriptions," dated December 10, 2002.

(vi) Beyond-design-basis earthquake seismic events were not considered applicable to the basemat design and therefore information on these was not provided in the LAW PCAR. This was acceptable to the reviewers because analysis of beyond-design-basis earthquake seismic events is not required by DOE-STD-1020-94 for PC-2 structures.

(vii) The reviewers found the calculations and design criteria for other external DBE structural analysis and design of basemat for the effects of design-basis winds, volcanic ash and snow as it relates to the basemat design to be acceptable because they were consistent with SRD Safety Criteria 4.1-4 requirements.

(viii) The reviewers found the safety functions and the operability of each feature required for seismic safety regarding the basemat design to be acceptable. The reviewers questioned the ventilation confinement requirements for the basemat (OSR Question LAW-PCAR-002). BNI responded that no limits for structural cracking were established because no confinement requirements were identified in the hazards and accident analysis. Concrete cracking is limited to ACI code requirements for normal operating and seismic conditions to ensure support of the SDC melter.

For other external DBEs, the reviewers evaluated design information in the general and facility-specific sections (2.4.3.4, 2.4.3.5, 2.4.3.6 and 2.4.3.13) in the LAW PCAR, associated analyses, and the responses to questions concerning the basemat's design and analysis for other external facility phenomena and events (e.g., snow, volcanic ash, wind, missiles due to wind, flooding, and mis-feed). The reviewers found the information provided for the six information areas identified in RL/REG-99-05, Section 4.6.3.3.2, to be acceptable. Each information area is summarized below:

(i) The reviewers found the wind loads that were quantified in calculation report 24590-LAW-S0C-S15T-00005 to be acceptable. This analysis documents that the facility's preliminary design satisfies the requirements for wind loads.

(ii) The reviewers found the PCAR, Section 2.4.3.6, statement that indicated that missiles due to wind are not applicable to the LAW building as a PC-2 structure per SRD Safety Criterion 4.1-4 to be acceptable because it was also consistent with the SRD, Table 4-2, and with DOE-STD-1020-94 for PC-2 structures.

(iii) No external flooding was considered for the LAW facility. The reviewers found this acceptable because, as stated in Volume I of the PCAR, Section 1.4.2.1, the WTP site is greater than 150 feet above the maximum postulated flood level.

(iv) The PCAR used design criteria for roof loads due to volcanic ash per Ashfall Load A of DOE-STD-1020-94 PC-2 criteria. Ash loading was considered concurrent with roof live loading as described and quantified in calculation report 24590-LAW-S0C-S15T-00006. This analysis showed that the facility meets the applicable design requirements for withstanding loading due to volcanic ash. The reviewers found this analysis to be acceptable.

(v) The PCAR used roof snow loads including snow drift based on a ground snow load of 15 psf per the PCAR, Section 2.4.3.4. This snow loading was considered concurrent with roof live loading as described and quantified in calculation 24590-LAW-S15T-00006. This analysis showed that the facility's preliminary design will meet the applicable requirements for withstanding loading due to snow. The reviewers found the analysis to be acceptable.

(vi) The evaluation of the LAW for accidental aircraft crashes[63] concluded that the frequency of an aircraft crash with enough energy to result in a release was $<1 \times 10^{-6}$/yr. In response to LAW-PCAR-068 concerning aircraft accidents, BNI stated that the postulated airplane crashes onto the LAW building would not affect the basemat because such loads are judged not to impact the basemat structural design. The reviewers found this to be acceptable.

The reviewers also found the calculational methods and software used in the non-seismic DBE evaluations to be acceptable and consistent with their applications.

As discussed above, the mis-feed event is also an external DBE. The reviewers determined that the PCAR adequately addressed the occurrence of this event by suitable controls in the PT facility and in the LAW facility to mitigate the event if it were to occur. The controls at the PT facility to prevent the mis-feed event include (1) a gamma monitor with interlocks to stop the transfer, (2) administrative controls for properly aligning valves and jumpers, and (3) administrative controls requiring sampling of vessels at the PT facility. The gamma monitor, related circuitry, and the administrative controls will be covered by TSRs. The single-failure criterion required by SRD, Volume II, Appendix B, Section 3, "Determination of SSCs for the Implementation of Defense in Depth," was satisfied by two controls: (1) the gamma monitor with interlocks at the PT facility that detects high-activity feed and stops transfer of such feed on detection and (2) the shield walls and associated cell access controls of the wet process cell. These controls prevent workers from being exposed to radiation levels above the radiation exposure standards of SRD Safety Criterion 2.0-1 in the event of the mis-feed.

[63] 24590-WTP-Z0C-50-00001, *Accident Analysis for Aircraft Crash into an RPP-WTP Facility*.

The reviewers evaluated the selection and analysis of external DBEs against the acceptance criteria and found them to be acceptable. The reviewers found the PCAR had adequately considered, described and analyzed the external DBEs that could affect safety, including seismic events, wind, flooding, volcanic ash, and snow. Reviewers found that the preliminary design adequately addressed the impacts on the basemat from these external events.

7. **Defining the Operating Environment** – The reviewers found the definition of operating environments and performance requirements to be acceptable. In accordance with requirements in the SRD, Appendix A, Section 4.7, "Definition of Operating Environment," the PCAR identified a set of bounding operating conditions and performance requirements of the LAW basemat. The bounding operating environmental requirements considered temperature, radiation levels, and chemical environmental requirements. The PCAR did not identify any special operating conditions for the basemat related to pressure, humidity, and radiation levels associated with performance of its safety function. The only operating environments and performance requirements for the basemat were associated with temperature in the pour cave area during normal operations and from the molten glass spill event during accident conditions.

   The reviewers found that this definition of operating environments and performance requirements for the basemat to be acceptable based on the use of bounding thermal conditions during normal and accident conditions. The reviewers agreed with BNI that the basemat was a passive design feature.

8. **Identifying Potential Control Strategies** – The reviewers found the identification of potential control strategies and documentation of required information for each ITS SSC using the format in Section 4.5.3.3.3, of RL/REG-99-05, to be conditionally acceptable. Information on potential control strategies was provided in Sections 3.3, 3.4, and 4.4 of the PCAR; CSD records in Appendix A of the submittal, including control strategy elements and safety case requirements identified in the CSD records; and in DBE calculation 24590-LAW-Z0C-S30T-00001. This information identified the potential control strategies associated with hazards, accident situations, and DBEs (seismic DBE, mis-feed event and the molten glass spill event). Chapter 4 of the submittal provided information for each ITS SSC using the format defined in Section 4.5.3.3.3 of RL/REG 99-05. For the LAW PCAR, the only identified ITS SSC was the basemat (an SDS SSC).

   For the mis-feed event, the response to Question LAW-PCAR-098 stated that administrative controls for sampling and verification programs to ensure that only in-specification feed is placed in the treated concentrate process tank in the PT facility. Valve and jumper line-ups will be verified before any material is transferred directly to the LAW facility. All material transferred to the LAW facility must pass through a gamma monitor before leaving the PT facility. Interlocks will prevent transfer if a high gamma level is detected. The SDS LAW wet process cell shield walls were also identified as a control to mitigate the consequences should a mis-feed occur. The gamma monitor, related circuitry, and the administrative controls will be covered by TSRs. The single failure criterion of the SRD, Appendix B, Section 3, "Determination of SSCs for the Implementation of Defense in Depth," was satisfied by the gamma monitor with interlocks at the PT facility and the shield walls and associated access controls of the LAW facility wet process cell.

The PCAR did not identify any internal DBEs for the LAW that imposed control strategy requirements on the basemat and only two external DBEs that could potentially affect the basemat: (1) seismic DBE and (2) the mis-feed event. For the seismic DBE, the PCAR identified control strategies associated with the passive nature of the structure's safety function. The facility structure, including the basemat, could, if it failed or malfunctioned, adversely affect the function of the SDC melter off-gas system by causing the melter off-gas system to become blocked. Therefore, the PCAR met SRD Safety Criterion 4.1-3, which requires SDS SSCs that solely have a chemical safety function to be categorized SC-III because such SSCs protect facility workers, co-located workers, and members of the public from exposure to NO_x.

The PCAR stated that no internal radiological DBEs imposed control strategies on the basemat. The basemat credited safety function was to prevent chemical (NO_x) consequences to the worker as discussed above. The reviewers identified that the basemat had an additional safety function to support the physical barrier of the process cell, as required by Table 1 of the SRD, Appendix B.

For all other internal DBEs, administrative controls were adequate to protect the facility workers given the low unmitigated doses (the highest calculated dose being 5 rem to a facility worker based on calculation 24590-LAW-Z0C-W14T-0003), acting in combination with the conservatively estimated initiating event frequency of 0.01 events per year.

In summary, the LAW PCAR identified safety functions performed by the SSCs located on or affecting the basemat as follows:

- "The LAW vitrification facility contains SDC systems and components that are important to safety (ITS) based solely on chemical hazards. The structure itself is designated as SDS because failure of the structure, as a result of an NPH event (causing a chemical hazard only), could reduce the functioning of the SDC systems and components contained within or supported by the structure."[64]

- "Based on the hazard analysis results, the only credited safety function provided by the LAW structure (including basemat) is to provide structural support (during seismic and other natural phenomena events) for the ITS exhaust stack and melter offgas system components that are credited for hazards represented by a release of melter offgas (refer to section 3.3.3.2)."[65]

[64] CCN: 024490, letter, A.R. Veirup, BNI, to M.K. Barrett, ORP, "Contract No. DE-AC27-01-RV14136 – Request for Review and Approval of the Partial Construction Authorization Request for the Hanford Tank Waste Treatment and Immobilization Plant," Attachment 2, "Activity Descriptions," dated December 10, 2002.
[65] 24590-WTP-PSAR-ESH-01-001-03, Section 3.3.3, "Hazard Evaluation Results," page 3-4.

- "The LAW structure is considered SDS to support the following credited safety function: The LAW structure provides support for ITS SSCs (for example, the SDC exhaust stack, pour caves, and melter offgas system) during normal and accident conditions. The analysis relies upon an unobstructed flow path to the exhaust stack to allow an elevated release in the event of a melter offgas release. The SDS safety function of the structure ensures that the exhaust stack and other ITS SSCs are not jeopardized by structural failure."[66]

Reviewers identified additional safety functions for the basemat based on the seismic DBE event being SL-2 for the facility and co-located worker, the mis-feed event being SL-1 for the facility worker, and the liquid spill/overflow from the LAW concentrate receipt vessel being SL-2 for the facility worker. The SRD, Appendix B, Table 1, requires two or more independent physical barriers for a SL-1 hazardous condition and consideration of two or more physical barriers for an SL-2 hazardous situation. In all of these hazardous situations, the basemat forms part of the second physical barrier. The basemat's classification as SDS is unaffected because none of these hazardous situations result in mitigated accident consequences approaching the radiological exposure standards of SRD Safety Criterion 2.0-1. The seismic category of the basemat remains SC-III in accordance with the SRD, Appendix B, and SRD Safety Criterion 4.1-4. The PSAR must be revised to include the additional safety functions for the basemat in the first revision of the PSAR after authorization for construction as a condition of acceptance.

9. **Documenting the Hazard Evaluation** – The reviewers found the documentation of the hazards evaluation and accident analysis to be acceptable, as presented in Chapter 3 and the CSD records in Appendix A of the submittal and in 24590-WTP-RPT-TE-01-004.

   Uncertainties in models (e.g., input assumptions, boundary conditions and modeling techniques), data, and phenomenology used in estimating accident consequences and frequencies were described in the calculations for DBEs. In the analysis of the DBEs, these calculations also identified other uncertainties and assumptions important to the results of the calculation. The reviewers evaluated these descriptions in the DBE calculations and found them to be acceptable, given the design's preliminary status.

4.1.2.3 Conclusions

The reviewers concluded that the results of LAW facility hazard and accident analysis for the preliminary level of design were conditionally acceptable. The reviewers also concluded that the hazards information, as supplemented by information in responses to the reviewer questions for the molten glass spill (Questions LAW-PCAR-039, -040, -043, -052, -055, -84, and -88) and the mis-feed event (Questions LAW-PCAR-098, -014, -051, -058, and -098) and in referenced calculations (see Section 8.0), was consistent with the current status of the facility and process

[66] 24590-WTP-PSAR-ESH-01-001-03, Section 4.4.1, "SDS Safety Function," p. 4-1.

design. The reviewers found that the radiological, nuclear, and process hazards associated with facility operation, including those from postulated accidents, were adequately assessed and that sufficient control or mitigation features were identified. The submittal, along with its referenced calculations and documentation in the formal responses to reviewer questions, adequately documented the safety basis for the construction of the LAW basemat.

Conditions of Acceptance – BNI must complete the following actions as conditions of acceptance of the LAW PCAR by the date or milestone indicated:

1. Correct the discrepancies related to the CSD records identification system used in SIPD and as referenced in the LAW and HLW PCARs texts and tables. This should be completed with the first revision of the PSAR after authorization for construction.

2. Revise the design calculation report 24590-LAW-DBC-S13T-00005 to incorporate the results of the computational fluid dynamics analysis of the pour cave. The analysis must confirm that the concrete temperatures of the melter and pour caves could be maintained within design limits during the postulated loss of cooling accident scenario. All structural calculations affected by the computational fluid dynamics analysis must be revised, as appropriate. These should be completed before authorization of full LAW facility construction.

3. Revise the PSAR to correct the omission of additional safety functions for the basemat based on the seismic DBE event being SL-2 for the facility and co-located worker, the mis-feed event being SL-1 for the facility worker, and the liquid spill/overflow from the LAW concentrate receipt vessel being SL-2 for the facility worker. This revision must be done with the first revision of the PSAR after authorization for construction.

4.1.3 LAW Facility Important-to-Safety SSCs

The purpose of this review was to determine whether the submittal adequately identified the LAW basemat ITS SSCs and the environmental conditions under which they must function.

4.1.3.1 Requirements

The submittal for the basemat must identify the most severe environmental conditions under which ITS SSCs in the LAW facility, including temperature, pressure, humidity, radiation level, and chemical environment.[67] The hazard control strategies selected must be shown to be consistent with the most severe environmental conditions identified. The operating environment during normal operations and under off-normal and accident conditions, as it affects the LAW basemat design-related ITS SSCs, were considered in determining hazard control strategies.

[67] SRD, Appendix A, Section 4.7, "Definition of Operating Environment."

The reviewers evaluated whether the submittal adequately determined and documented each LAW basemat-affecting ITS SSC, using the format described in Section 3.4.1[68] of this SER. The six elements, which are repeated for each ITS SSC, were (1) SSC identification, (2) safety function, (3) system description, (4) functional requirements, (5) system evaluation, and (6) controls (TSRs).

4.1.3.2 Evaluation

Based on the hazard and accident analysis, the reviewers observed that the basemat-affecting ITS SSCs were those with safety functions that affect the basemat. The PCAR characterized the safety functions of the basemat as follows:

> "The LAW structure is considered SDS to support the following credited safety function.
>
> The LAW structure provides support for ITS SSCs (for example, the SDC exhaust stack, pour caves, and melter offgas system) during normal and accident conditions. The analysis relies upon an unobstructed flow path to the exhaust stack to allow an elevated release in the event of a melter offgas release. The SDS safety function of the structure ensures that the exhaust stack and other ITS SSCs are not jeopardized by structural failure."[69]

Reviewers identified an additional safety function for the basemat based on the seismic DBE event being SL-2 for the facility and co-located worker, the mis-feed event being SL-1 for the facility worker, and the liquid spill/overflow from the LAW concentrate receipt vessel being SL-2 for the facility worker. The SRD, Appendix B, Table 1, requires that two or more independent physical barriers are required for a SL-2 hazardous condition. The second barrier against the release of radiological material would be the cell walls and the basemat. The additional safety function of the basemat is to not fail in such a way that the cell walls cannot perform their safety function. The seismic category of the basemat remains SC-III in accordance with the SRD, Appendix B, and SRD Safety Criterion 4.1-4 because the unmitigated radiological consequences of this event meet the radiological exposure standards for an unlikely event. The PSAR must be revised to correct this omission in the first revision of the PSAR after authorization for construction as a condition of acceptance. The reviewers found all six of the criteria to be acceptably met. The evaluation of the information for each criterion applies only for the basemat structure:

1. **SSC Identification –** The PCAR identified the basemat structure as the only basemat-affecting SDS SSC. The reviewers agreed that the appropriate classification of the basemat was SDS.

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[68] RL/REG-99-05, Section 4.5.3.3.3, "Regulatory Acceptance Criteria."
[69] 24590-WTP-PSAR-ESH-01-001-03, Section 4.4.1, "SDS Safety Function," p. 4-1.

2. **Safety Function –** The reviewers found the description of the safety function of the LAW basemat (i.e., providing support for ITS SSCs such as the SDC exhaust stack, pour caves, and melter off-gas system) to be conditionally acceptable. The PSAR must be revised to add the safety function of supporting the cell walls, as discussed in Section 4.1.2, Item 8, of this SER. The basemat provides structural load-carrying capability for the SSCs credited in preventing/mitigating the melter offgas release event, the preliminary consequence of which was a hazardous chemical release of NO_x. As such, the LAW facility structure, including basemat, was designated SC-III for earthquakes and was designed to meet PC-2 requirements for other NPH events, as specified by SRD Safety Criterion 4.1-4 requirements.

3. **System Description** – The reviewers found the LAW system description related to the basemat to be acceptable. Sections 2.3.2, 2.4.11.13, 2.4.11.14, and 4.4.1.2 of the LAW facility-specific submittal that described the LAW structure, including the basemat, embedments, sumps, and wall penetrations were reviewed, as was Section 2.3.2 describing the basemat as SDS.

4. **Functional Requirements –** The reviewers found the description of the basemat's functional requirements to be conditionally acceptable, as provided in Section 4.4.1.3. The PSAR must be revised to add the functional requirement to not fail in such a way that the cell walls cannot perform their safety function, as discussed in Section 4.1.2.2, Item 8, of this SER. Based on natural phenomena considerations, the LAW facility structure will be designed to meet the requirements of SRD Safety Criteria 4.1-2, 4.1-4, and 4.1-5. Only these SRD safety criteria are applicable to the safety function of the LAW basemat. The seismic analysis methods provided in calculation reports 24590-LAW-S0C-S15T-00003 and 24590-LAW-S0C-S15T-00004 were found to be acceptable based on the response to Question LAW-PCAR-093 concerning the finite element analysis model and calculation CCN-031866.[70] The reviewers agreed with this conclusion because the design requirements were found to be appropriately defined and the referenced calculations demonstrated that the basemat met these requirements. Section 4.4.1.4 of the submittal described the ACI-318-99 design standards that were applied to the LAW structure, including the basemat. The basemat will also be designed and constructed to SC-III requirements for earthquakes and to PC-2 requirements for other NPH events. The reviewers concluded that the basemat's design according to these standards was appropriate.

5. **System Evaluation –** The reviewers found the systems evaluation of the basemat to be acceptable, as discussed in Section 4.4.1.5 of the LAW facility-specific submittal. Reviewers assessed the statement in the submittal that the basemat of the LAW facility had been evaluated using conservative loads to identify the maximum loads on the foundation. Calculation report 24590-LAW-DBC-S13T-00008, *Preliminary Foundation Sizing*, confirmed that the basemat thickness was adequate to accommodate the identified loads. The basemat was designed to perform its SDS safety function during normal and

[70] CCN: 031866, letter, M. Scott, BNI, to D. Houghton, BNI, "Responses to LAW Preliminary Construction Authorization," dated April 10, 2002.

accident conditions. This ensures that the ITS function of the basemat will be available when required, per the hazard and accident analysis.

6. **Controls (TSRs) –** No TSRs were provided with the LAW PCAR. In Section 4.4.1.6, the PCAR stated that the structure was a passive design feature for the LAW facility and did not require frequent maintenance or surveillance. The PCAR did not identify any safety limits relative to the basemat because the hazard analysis did not identify any process variables associated with the basemat that could cause a direct release of unacceptable levels of radioactive material to workers or the general public. The reviewers agreed with this rationale.

4.1.3.3 Conclusions

The reviewers concluded that acceptable information was provided in the submittal and supporting calculations to understand the performance requirements for the basemat. The reviewers found the description of the basemat as the only basemat-affecting ITS SSCs to be acceptable. The reviewers found the basemat was appropriately classified as an SDS SSC.

4.1.4 LAW Facility TSRs

No TSRs were identified for the LAW facility basemat. Additional information on TSRs for the full LAW facility will be submitted with BNI's LAW PSAR.

4.2 HLW Facility

The scope of the HLW activities covered in Volume IV, *HLW Facility Specific Information,* of the PCAR is the construction of the HLW basemat. To accomplish this construction, the following specific activities are required: installing FRE for the basemat, installing the ground grid connections to HLW basemat rebar, placing the HLW basemat concrete, and backfilling the HLW basemat.

4.2.1 HLW Facility Description

The purpose of this review was to determine whether the submittal adequately described the HLW facility and processes that were encompassed by the PCAR and that could affect any safety functions, hazards, or potential accidents (at the completed facility) and their consequences. Examples of facility features are facility location, facility design information, and the location and arrangement of buildings on the facility site. Examples of process features are the general arrangement, function, and operation of major components of the processes for treating HLW.

4.2.1.1 Requirements

The requirements for the HLW facility and process descriptions were parallel to the review criteria listed previously in Section 3.2.1 and Section 4.1.1.1 but limited to the HLW basemat.

Facility Description – For the HLW facility basemat, the facility description criteria included (1) location, (2) layout and location of buildings, (3) ability to resist failures of ITS SSCs, (4) imposed design limits for quantifying the structural behavior of the concrete and steel structures, (5) design and analysis processes used for the basemat, (6) basemat electrical systems and components, (7) basemat ventilation and air cleaning systems and components, (8) protection of control room atmospheres, and (9) effluent stacks. For the HLW PCAR, the requirements were reviewed only to the extent that they were relevant to the basemat.

Process Description – For the HLW facility, the process description criteria included (1) a general description of the process, (2) the general arrangement of the major components of the process, (3) a discussion of process design, (4) the operating ranges and limits for process variables, (5) process equipment layout, (6) process design-related codes and standards, (7) instrumentation and controls required for monitoring the process, and (8) process systems for waste management.

4.2.1.2 Evaluation

The results of the reviewers' evaluation of facility and process descriptions are summarized separately below.

Facility Description – The reviewers found that eight of the nine criteria were acceptably met. The reviewers evaluated the HLW facility-specific information contained in Volume IV of the PCAR submittal, structural and seismic calculations referenced in the HLW PCAR, and responses to OSR questions concerning the structural design and analysis of the HLW basemat and basemat-to-wall connections. The evaluation of the information for each review criterion is discussed below:

1. Information on facility location was discussed in Section 3.2.2 of this SER and was found to be acceptable because the information was adequate to perform the necessary safety evaluation and to define the design basis conditions for the basemat.

2. The reviewers found acceptable the information on the general layout and location of the HLW facility showing its major structural features and describing the major processes that will be ongoing in this facility. The level of detail provided was adequate for performing the safety analyses necessary for evaluating the PCAR for the HLW basemat.

3. The reviewers found acceptable the design information on the ability of the HLW basemat to resist failures of its safety functions due to credible internal and external events. Specifically, the evaluation included the following types of loads listed in Item 3, Section 1.2.3.3, of RL/REG-99-05:

(a) **Loads Encountered During Pre-operational Testing, Startup, and Shutdown –** The submittal did not address the loads that may be encountered during pre-operational testing, startup, and shutdown. In response to an OSR request to clarify the applicability of pre-operational testing, startup, and shutdown loads to the basemat design, BNI confirmed[71] that no such load would affect the basemat design "beyond those outlined in the criteria for normal operating design conditions." The reviewers found this acceptable because the PCAR involved constructing the basemat only, and these structural components were not likely to encounter any loads that were not enveloped by the other normal operational, accidental, and external event loads that had been considered in the design.

(b) **Loads Encountered During Normal Operation** – The reviewers found acceptable the information on the following loads that may be encountered during normal operation: dead load, live load, snow load, ashfall load, wind load, thermal loads, fluid load, pipe reaction load, and lateral earth pressure load. Some of these loads were defined quantitatively, while for others only the basis for selection was described. The PSAR did not adequately address loads that may result from creep and shrinkage. However, additional information on creep and shrinkage was provided in response to Question HLW-PCAR-090. With this additional information, the reviewers found the definition of loads during normal operation to be complete and acceptable for the design of the basemat.

(c) **Construction Loads –** The reviewers found the information on construction loads to be acceptable. While Section 2.4.3.14 of the HLW PCAR did not address the construction loads adequately, especially the loads that may develop in the basemat because of the construction sequence, BNI evaluated the basemat for construction sequence loads. Because the resulting stresses were calculated to be very small and negligible, the reviewers found the treatment of construction loads acceptable.

(d) **Loads to be Sustained During Severe and Extreme Environmental Conditions –** The reviewers found acceptable the information on the definition of the following loads that may result from severe and extreme environmental conditions and external DBEs: extreme wind load, design basis earthquake load, extreme flood load, and extreme wind generated missile impact load. The information was acceptable because it was consistent with Table 4-1 of SRD Safety Criterion 4.1-3, the applicable criterion for an SDC SSC.

(e) **Loads Resulting from Abnormal Plant Conditions –** The submittal did not specifically address any loads designated as "abnormal plant condition loads."

[71] CCN: 034673, Internal BNI memo, D. Houghton to R. Garrett, "Miscellaneous Outstanding Issues Associated with HLW Basemat Design," dated May 31, 2002

However, in response to an OSR request to further clarify this issue, BNI stated[72] that loads were classified as either normal or accidental, implying that abnormal plant condition loads were treated as a subclassification of accidental loads. The reviewers found this acceptable because the HLW basemat structural design accounted for the loads from all credible accident scenarios postulated in the facility hazard and accident analysis.

(f) **Loads Resulting from Accident Conditions –** Section 4.2.2 of the SER discussed identification and definition of the scenarios involving accidental molten glass spills, accidental drops of heavy objects onto the basemat, and accidental aircraft impact on the HLW building. Structural evaluations of the basemat for these three types of accident scenarios are addressed below:

(i) Structural Evaluation of Thermal Loads Resulting from Accidental Glass Spill – The reviewers' evaluation of the selection of the size (i.e., quantity) and location of the glass spill onto the basemat is addressed in Section 4.2.2 of this SER. In response to Question HLW-PCAR-012 concerning the glass spill, BNI provided analyses and calculations defining the transient temperature profiles in the basemat that would result from the accidental molten glass spill. Concrete temperatures were based on a one-dimensional analysis of a spill into a catch pan in calculation report 24590-HLW-U0C-30-00003, *Analysis of HLW Melter Unplanned Pour Using HADCRT Computer Code*. Temperatures associated with the glass spill were integrated with the normal operating steady state temperatures calculated in the three-dimensional computational fluid dynamics (CFD) analysis of calculation report 24590-HLW-RPT-HV-02-002, *Thermal Analysis Summary to Support –21'-0" Elevation Concrete Design*. The methodology used was provided in a BNI memo.[73]

Using these accident temperatures, a structural evaluation was performed, 24590-HLW-S0C-S15T-00016, *Thermal Loads*. The reviewers evaluated the methods used in these calculations and found them to be acceptable and consistent with the guidance provided in ACI 349-01 and ACI 349 R01, *Reinforced Concrete for Thermal Effects on Nuclear Power Plant Structures*.

The reviewers determined that the methodology used was an approximate, simplified method. The methodology predicted a small thermal gradient (approximately 21 degrees F) due to the 2700 L glass spill. The low gradient was a result of BNI's decision during the PCAR review to add a catch pan to capture glass spills up to 2700 L, and protect the basemat

[72] CCN: 034673, Internal BNI memo, D. Houghton to R. Garrett, "Miscellaneous Outstanding Issues Associated with HLW Basemat Design," dated May 31, 2002

[73] CCN: 031402, Internal BNI memo, R. Crowe to R. Jorissen, "Melter Spill Accident Temperatures," dated May 3, 2002.

using a six inch gap between the pan and the floor. However, the reviewers were concerned that the analysis does not accurately model heat sources, HVAC airflow and heat transfer to predict the temperature conditions for the design basis 2700 L glass spill. The reviewers determined that this approach was conditionally acceptable, because the catch pan provides protection of the floor from overtemperature, and the methodology used predicted only a small temperature rise due to the spill. To reduce the uncertainty in the original analysis, a condition of approval of the HLW PCAR is to perform a transient CFD analysis of the design basis 2700 L glass spill before authorization of full HLW facility construction.

(ii) Structural Evaluation of Basemat Slab Subjected to Impact Loads Resulting from Accidental Drop of Heavy Objects – The reviewers' evaluation of the selection of the size and locations of dropped loads and drop heights is addressed in Section 4.2.2 of this SER. A structural evaluation of the basemat slab for these defined drops was performed in calculation 24590-HLW-DBC-S15T-00001, *Evaluation of Impact Loads*, and concluded that impact absorbers will be needed to protect the basemat slab. The reviewers found the evaluation to be incomplete because (a) not all the potential failure modes were considered, e.g., shear failure resulting from an impact close to the wall, and (b) the level of permissible damage to the basemat was not determined from safety and environmental considerations.

In response to DOE's request to further clarify the first issue, BNI stated[74] that consideration was given to the potential of a canister drop adjacent to the wall. However, because the canister's length was long compared with the width of the hatch through which the canister was postulated to drop, BNI concluded that, "it is extremely unlikely for the canister to travel through the hatch and not strike anywhere but the center of the tunnel floor." BNI further stated that, "If however, the scenario could occur, where the canister struck the basemat/wall interface, the resulting crack at the location would have to exceed over six square feet in order to lose C5 ventilation depression. A crack resulting in this magnitude of penetration is not expected given the worst case loading assumptions." The reviewers agreed that the probability of the canister impacting close to the wall was low. While it is difficult to estimate whether this probability would be low enough to consider this scenario incredible, the reviewers agreed with the BNI assessment that even if such a low probability event occurred, it would not result in cracks with a combined flow area equivalent to a six-square-foot opening. Therefore, the structural evaluation of the load drop scenarios was acceptable.

[74] CCN: 034673, Internal BNI memo, D. Houghton to R. Garrett, "Miscellaneous Outstanding Issues Associated with HLW Basemat Design," dated May 31, 2002

In response to DOE's request to further clarify permissible damage to the basemat, BNI addressed in the same letter the issue from the standpoint of the potential soil contamination and personnel safety. Addressing the soil contamination issue, BNI stated, "If the material should leak through the basemat to the soil column there are no acceptance criteria to evaluate the acceptability of the release." However, BNI stated that the basemat design would adequately minimize potential leaks due to cracking because (a) "in areas associated with liquid storage or decontamination activities the basemat will be lined or coated to support these activities," and (b) if the basemat cracks due to a load drop, the surface of the cracks would not be smooth or flat but rough edged and "provide a tortuous path for liquids to travel from the cell floor to the soil column." In the absence of an established quantitative criterion for acceptable leakage to the soil from environmental and decontamination considerations, the reviewers agreed with this qualitative assessment.

With respect to personnel safety from radiological considerations, BNI stated, "the consequences to the co-located worker adjacent to the facility are expected to be well below the radiological exposure standards (i.e., since there would be approximately 33 ft of soil above the subsurface pool). As discussed in the TWRS EIS due to the nature of the soil column and the pH of the waste streams, the waste will be confined to the soil column below the facility and not represent a hazard to the public receptor as defined in the SRD." Again, the reviewers agreed with this qualitative assessment.

(iii) Structural Evaluation of Basemat Slab Subjected to Impact Loads Resulting from Accidental Aircraft Crash – The accidental impact of aircraft onto the HLW building was evaluated in calculation report 24590-WTP-Z0C-50-00001. The calculation concluded that the frequency of an aircraft crash with enough energy to result in a release from the WTP was $<1 \times 10^{-6}$/yr. The reviewers found that the information in this calculation was not adequate but agreed with BNI that, because the structural effect of a small general aviation aircraft impacting on the HLW facility was likely to be insignificant on the basemat, the evaluation was acceptable for the basemat. The resolution of this issue will be addressed as part of the full HLW facility PSAR review process.

(g) **Load Combinations** – The applicable load combinations for reinforced concrete and structural steel design were listed in Section 2.4.4.1.4.1 of Volume I of the PCAR and in the calculation report 24590-HLW-S0C-S15T-00020, *Concrete Structure Analysis*. As noted in Section 3.2.2 of this SER, the reviewers found these load combinations to be acceptable because they were consistent with the requirements of SRD Safety Criterion 4.1-3 codes and standards, the applicable criterion for the SDC basemat.

4. The reviewers found acceptable the information on imposed design limits for quantifying the structural behavior of the concrete and steel structures. To evaluate whether the PCAR referenced the appropriate design limits and structural acceptance criteria, the calculations used for the basemat design were evaluated: 24590-HLW-S0C-S15T-00020 and 24590-HLW-DGC-S13T-00002, *Foundation Slab Rebar Below Grade.* Also reviewed was the method used to determine design basis moments, shears, and forces in the basemat resulting from normal operating loads using analysis methods and load combinations. In their initial review, the reviewers found, with two exceptions, the methods used in these calculations and the results to be acceptable because the methods used to determine the demands and capacities were consistent with DOE-STD-1020-94 and other applicable codes. The exceptions were that (a) the quantification and treatment of the loads resulting from through-thickness thermal gradients were incomplete; and (b) BNI had not completed the design of dowels that would be needed for rigidity at the basemat-to-wall connections.

   Subsequently, in response to Question HLW-PCAR-131 concerning through-thickness thermal gradients, BNI performed additional analyses to properly quantify loads and presented a method of treating these loads in designing reinforcing steel in the basemat. The reviewers found the method to be acceptable because it was consistent with the general provisions of ACI 349-01 and ACI 349 R01.

   The reviewers also found the basemat to be structurally adequate because the demand/capacity ratios for the most critical areas of the basemat, presented by BNI in response to Question HLW-PCAR-131, were noted to be equal to or less than unity. BNI also addressed concerns regarding the rebar or dowel design in response to Question HLW-PCAR-131. They calculated the demand/capacity ratios for the most critical areas of the basemat-to-wall connections and provided these to DOE to demonstrate the structural adequacy of the wall connections. These ratios were calculated considering the combined effects of thermal growth and through-thickness gradient and other applicable loads using the same method used for the basemat. Therefore, the reviewers found the dowel design acceptable.

5. The reviewers found acceptable the information on the structural design and analysis processes used for the basemat, including the process for validating and verifying structural and thermal analysis codes because the design and analysis process conforms to the applicable SRD Safety Criterion 4.1-3 implementing standards, including the requirements specified in DOE-STD-1020-94; ASCE 4-98, *Seismic Analysis of Safety Related Nuclear Structures*; and ACI 349-01.

6. Because the PCAR involves the construction of the basemat only and no ITS electrical systems have any effect on the basemat's structural adequacy, the reviewers found the lack of information on ITS electrical systems and components to be acceptable. The reviewers evaluated the information submitted on the electrical grounding system. The reviewers found the description of the electrical grounding system to be consistent with the industry standards for electrical grounding systems. The PCAR commited to designing and analyzing the electrical grounding system per IEEE Standard 142,

Recommended Practice for Grounding of Industrial and Commercial Power Systems and NFPA 70, Article 250. In the Limited Construction Authorization Request (LCAR) (Section 1.3.2.3), BNI provided a general description of the functions of the electrical grounding system. The LCAR stated that electrical equipment was connected to the grounding system to provide personnel and equipment protection for an electrical fault, but connection to the grounding grid was not required for operation of the electrical equipment. The LCAR further stated that degradation and malfunction of the grounding system would not impact the functionality of the ITS electrical equipment, and concluded that, the electrical grounding system was not ITS. The reviewers agreed that the electrical grounding system was not ITS, and had no potential to adversely impact ITS structures, systems, or components. On this basis, the reviewers concluded that construction of the grounding grid was acceptable, and should be authorized.

7. The reviewers evaluated the information in Section 2.6 of the PCAR and found it to be acceptable. Calculation report 24590-HLW-MAC-C5V-00004, *HLW C5V HVAC Equipment Sizing and Selection,* provided the analysis on sizing the C5 ventilation ducts. Three sections of the C5 ventilation ducts are embedded in the HLW facility basemat. Two 24-inch duct sections are vented from the floor of each pour tunnel and routed under the walkway to the drum transfer tunnel. The other section is a 36-inch duct that is routed in the basemat from the secondary offgas area to the filter cave at elevation 0’00".

8. The reviewers determined that protecting control room atmospheres was not pertinent to the ITS functions of the basemat; therefore, it was not evaluated.

9. The reviewers found acceptable the information on the representation of the effluent stack in the structural and seismic modeling of the HLW building as it related to the structural integrity of the basemat. The information was acceptable because the stack was appropriately included in the analytical model used for the basemat design. The reviewers observed that the preliminary stack design was not completed. The reviewers concluded this was acceptable because the stack's structural design will have insignificant effect on the basemat. The stack design does not have to be completed to accept the safety case for the basemat.

Process Description – The reviewers found five of the eight acceptance criteria had been met, one was conditionally acceptable, and the remaining two were not applicable to the basemat. The review was limited to SSCs that had a potential to impact the basemat. The evaluation of the information for each review criterion is summarized below:

1. The reviewers found acceptable the discussion of the basic theory of the process and overview of the operating logic, process flow diagrams, chemical formulae, reaction equations, radiolytic reactions, feed constituents, reagents, products, byproducts, effluents and other waste streams as it related to the basemat. In the overview of the HLW process provided in Section 2.5 of the submittal, the reviewers found that enough general information was provided to understand the implications for the HLW facility basemat.

2. The reviewers determined that the information on the general arrangement, function and operation of major components for the HLW process, as described in Section 2.5, was acceptable. In calculation report 24590-HLW-U0C-30-00003, BNI specified that additional rebar was to be provided to support the thermal expansion loads for the embedded C5 ventilation duct that is routed under the walkway from the pour tunnel to the drum transfer tunnel. The reviewers found the calculation results to be acceptable.

3. The reviewers found the process design, materials of construction, equipment design, and process-control logic and instrumentation to be consistent with the requirements of the SRD and therefore acceptable.

4. The reviewers found acceptable the operating ranges and limits of measured process variables used in the engineered or administrative controls applicable to the basemat. Specifically, the reviewers evaluated and found acceptable the use of a 2700 L (40% volume) catch pan and physical controls to control glass spills, as detailed in calculation report 24590-HLW-U0C-30-00003 and the use of an impact absorber to mitigate canister drops, as detailed in calculation report 24590-HLW-DBC-S15T-00001.

5. The reviewers found the information on the HLW facility process equipment layout and general arrangement as related to the basemat to be conditionally acceptable. The general arrangement drawings[75] that were used in the hazard and accident analysis of the HLW facility did not reflect changes that had been made in the pour tunnel and contained incorrect vessel names and numbers. In response to Question HLW-PCAR-114 relative to the C5 ventilation ductwork, BNI stated that the design drawings that were used to support the hazard and accident analysis of the embedded C5 ventilation ductwork in the basemat would be revised to reflect the configuration used in the accident analysis. This revision must be completed with the first revision to the PSAR after authorization for construction as a condition of acceptance.

6. The reviewers found the codes and standards identified for the basemat design and construction to be acceptable, consistent with SRD Safety Criterion 4.1-2.

7. Instrumentation and controls for monitoring the process and safely shutting down the process were not considered part of the review scope for the basemat; therefore, they were not evaluated. This information will be evaluated with the HLW PSAR.

8. Design of the facility process systems to minimize waste production was not considered part of the basemat review scope; therefore, it was not evaluated. This information will be evaluated with the HLW PSAR.

[75] 24590-HLW-P1 GO1T-00001, DWG-W375 HV-PL00016, DWG-W375 HV-PL00017, DWG-W375 HV-PL00018, DWG-W375 HV-PL00019, DWG-W375 HV-PL00020, 24590-HLW-P1 GO1T-00008, 24590-HLW-P1 GO1T-00009, 24590-HLW-P1 GO1T-00010, and 24590-HLW-P1 GO1T-00011.

4.2.1.3 Conclusions

The conclusions for the facility and process descriptions are summarized separately below.

Facility Description – The reviewers concluded that the facility description, particularly the structural design of the basemat and the basemat-to-wall connections, was acceptable using the acceptance criteria in Section 1.2.3.3 of RL/REG 99-05.

Process Description – The reviewers concluded that the process description related to the basemat was conditionally acceptable using the acceptance criteria in Section 1.2.3.3 of RL/REG-99-05.

Conditions of Acceptance – BNI must complete the following by the date or milestone indicated:

1. Revise the design drawings that were used to support the hazard and accidental analysis of the embedded C5 ventilation ductwork to reflect the configuration used in the accident analysis with the first revision of the PSAR after authorization for construction.

2. Perform transient computational fluid dynamics analysis of the design basis event 2700 L molten glass spill before authorization of full HLW facility construction.

4.2.2 HLW Facility Hazard and Accident Analysis

The purpose of this review was to determine whether the PCAR adequately described the hazard and accident analyses performed for the HLW basemat and whether the analyses complied with requirements of the SRD and were consistent with the commitments of the ISMP. The review also was to determine whether the analyses demonstrated that the HLW basemat design, construction, operation, maintenance, and deactivation could be performed in a manner that adequately protects the health and safety of the workers, the public, and the environment.

4.2.2.1 Requirements

In accordance with SRD, Volume II, Appendix A, Section 4.0, "Hazard Evaluation," the submittal was to address the following nine elements of hazard and accident analyses: (1) identifying hazards; (2) identifying potential accident/event sequences; (3) estimating accident consequences; (4) estimating accident frequencies; (5) considering common-cause and common-mode failures; (6) defining DBEs; (7) defining the operating environment; (8) identifying potential control strategies; and (9) documenting the hazard evaluation.

For internal DBEs, the evaluation must assess the identification and analyses of internal DBEs that affect the basemat design and the process used to define DBEs.[76] For external DBEs, the evaluation must assess both selection of the seismic events for the basemat and the seismic design criteria.[77] The assessment also must evaluate other external DBE events, such as design-basis winds, missiles propelled by wind, volcanic ash and snow loads, and man-made external events such as aircraft crashes. Facility preliminary seismic analyses also must be evaluated to ensure that the preliminary basemat design would meet applicable requirements for load when subjected to the design-basis earthquake.

Consistent with the current level of design, the evaluation must assess the chemical process safety of the basemat design and whether potential chemical hazards associated with the basemat had been adequately identified.

4.2.2.2 Evaluation

The reviewers evaluated the HLW facility-specific hazard and accident analysis submittal as it pertained to construction of the basemat. The reviewers evaluated the information provided in Chapter 3 and Appendix A of the submittal. The reviewers also evaluated references in the submittal to assess the scope, breadth, and depth of the detailed information underlying the discussion and to determine the completeness and accuracy of the underlying information in supporting the conclusions. The calculation reports listed in Section 8.0 of this SER were also reviewed to determine the implementation and documentation of the ISM process as it applied to the HLW hazards and accident analysis results. These references included calculations, studies, drawings, system notebooks, additional detailed printouts from the SIPD database, system description reports, and other relevant supporting documentation.

The reviewers found six of the nine criteria to be acceptably met and three to be conditionally met. The evaluation of the information for each review criterion is summarized below:

1. **Identifying Hazards** – The reviewers found the PCAR's identification of hazards to be acceptable. The reviewers evaluated Chapter 3 and CSD records in Appendix A of the HLW PCAR and the results of the hazard analysis in report 24590-WTP-RPT-TE-01-002, *Design Basis Event Selection for the High Level Waste Vitrification Facility, Preliminary Safety Analysis Report*. The reviewers evaluated the results of the identification of hazards associated with the processes, design, and operations that could affect the basemat and a list of those hazards, their potential consequences, possible causes, and estimated initiating frequencies.

   The PCAR identified all CSD records for basemat-affecting hazards that could produce radiological consequences above SL-4 and chemical consequences above threshold. BNI provided a complete hazard identification, including SL-4 hazards, in 24590-WTP-RPT-TE-01-002. The submittal documented the hazards identification results in Section 3.3.2.

[76] RL/REG-99-05, Section 4.5, "Internal DBEs."
[77] RL/REG-99-05, Section 4.6, "External DBEs."

These results included identification of the hazardous chemicals and a discussion of possible chemical interactions. The hazard evaluation results were provided in Section 3.3.3 and in Appendix A. Results were included for the HLW common areas, receipt and blending systems, melter and melter offgas systems, canister handling and storage areas, maintenance and breakdown area, liquid effluent systems, reagent systems, HVAC systems, and instrument and control and utility supply systems. Hazardous situations were identified involving chemical releases, loss of contamination control, spray leaks, canister drops, fire, boiling, explosion, liquid spill, vessel overflow, pressurized release, seismic event, direct radiation, criticality, chemical reaction, offgas release, and molten glass spills. A subset of these, a canister drop, a seismic event, and molten glass spills, were identified as hazards that could impose functional requirements on the basemat. Of the 602 CSD entries reviewed in the HLW facility hazards identification process, 178 had SL-1 and -2 and above threshold consequences to the facility worker, and 87 of the 178 events had SL-1 or -2 consequences to the co-located worker.

As noted in the LAW facility hazard and accident analysis evaluation (Section 4.1.2.2, Item 1 of this SER), many discrepancies concerning the CSD records and the HLW PCAR were identified. These discrepancies between the CSD records and the HLW PCAR text and tables must be corrected as a condition of acceptance for the HLW PCAR. This should be completed with the first revision of the PSAR after authorization for construction.

The HLW facility was categorized Hazard Category 2 using DOE-STD-1027-92. The reviewers evaluated the basis for this categorization (24590-HLW-Z0C-U10T-00001, *HLW Facility Hazard Categorization and Chemical Hazards Identification*) and found it to be acceptable.

The reviewers found the PCAR's radiological hazard analysis to be acceptable because the hazards associated with the defined work were identified systematically according to the SRD, Appendix A, Section 4.1, "Identification of Hazards."

2. **Identifying Potential Accident/Event Sequences** – The reviewers found the PCAR's approach to identifying potential accident/event sequences to be acceptable. The reviewers evaluated Chapter 3 and CSD records in Appendix A of the submittal and the results of the hazard analysis in report 24590-WTP-RPT-TE-01-002. The reviewers evaluated the results of the systematic and structured process for identifying potential accident/event sequences associated with the processes, design, and operations that could affect the basemat.

   The HLW PCAR identified CSD records for basemat-affecting hazards that could produce radiological consequences above SL-4 and chemical consequences above threshold. The CSD records included information on the potential consequences, a summary of their hazardous situations or sequences, estimated initiating frequencies, control strategy elements, and safety case requirements of administrative controls or engineered features for each hazard. In Section 3.3.3, the PCAR summarized potential hazardous situations or accident sequences for the SSCs by their location. The PCAR described the rationale for sorting internal hazardous situations (internal events) into accident groups or categories (i.e., liquid spills and chemical reactions) and for selecting specific cases to be analyzed in more detail and the basis for selecting the accident sequences. In Section 3.4.2, the external events were described. Both internal and external event sequences are discussed below.

(a) **Internal Events** – The reviewers found the description of internal events to be acceptable. The PCAR identified three types of internal DBEs that could impose functional requirements on design of the basemat or the embedded C5 ventilation system ductwork: (1) liquid spills/leaks (control strategy involved facility structure and C5 ventilation system), (2) molten glass spills (structural and thermal impacts to basemat and walls and challenges to C5 ventilation system), and (3) canister drops (impacts to basemat structural integrity and potential impacts to the embedded C5 ventilation ductwork).

(b) **External Events** – The reviewers found the description of external events to be acceptable. The reviewers evaluated Section 3.4.2 of the submittal for the impacts of external events on the HLW basemat, where such impacts would directly affect the facility basemat or would impose any design requirements (e.g., seismic) on the basemat. The only external DBE included in the section was the seismic DBE. The analysis of the seismic DBE assumed that during the earthquake all SC-I and SC-II SSCs continue to function and all SC-III and SC-IV SSCs fail. The scenario was comprised of multiple events or failures, including process vessel failures, canister drops, melter failures, and bulk chemical vessel failures.

The PCAR considered other external natural or man-made events, such as flooding, wind, ash and snow fall, and aircraft crashes, for their impact on the basemat design. The PCAR concluded that these events had no impact and imposed no design requirements on the basemat, confirming that the seismic DBE was the only external DBE for the HLW basemat. The reviewers agreed with the conclusion. Based on the lack of impact on the functional requirements of the basemat, the reviewers found the limited reference to the evaluation of secondary events directly caused by external events (such as hazards from other facilities, aircraft crashes, pipeline ruptures, and truck crashes) to be acceptable. As noted in Section 4.2.1.2, Item 3(f)(iii) above, the effects of aircraft crashes on the balance of the HLW facility will be addressed as part of the HLW PSAR review.

3. **Estimating Accident Consequences** – The reviewers found the approach to estimating accident consequences to be conditionally acceptable. The reviewers evaluated Chapter 3 and the CSD records in Appendix A of the submittal and the results of the unmitigated consequence analysis in calculation report 24590-HLW-Z0C-W14T-00013, *Revised Severity Level Calculation for the HLW Facility*. The evaluation considered the description of the results of the calculated unmitigated and mitigated consequence analysis for the potential accident/event sequences associated with the process, design, and operational hazards that could affect the basemat.

The submittal identified CSD records for basemat-affecting hazards (including their potential radiological and chemical hazard consequences for facility and co-located workers and the public) that could produce radiological consequences above SL-4 and chemical consequences above threshold. Section 3.3.3 of the HLW PCAR summarized the consequences of these events for the internal accident sequences.

Reviewers questioned the use of less-than-Contract maximum concentrations of certain radionuclides, including ^{241}Am in severity level (unmitigated consequence) and DBE (mitigated consequence) calculations. In response to Question HLW-PCAR-053 concerning radionuclide content, BNI stated that "based on the mitigated consequences for basemat affecting DBEs, the increase in the ULDF (unit liter dose factor) as a result of increasing the ^{241}Am to contract maximum value would not result in mitigated consequences above the radiation exposure standards of SRD Safety Criterion 2.0-1. Therefore, increasing the ^{241}Am concentration to the contract maximum would not affect the basemat design or construction. In particular, the embedded C5 ventilation ductwork would not be changed due to a ^{241}Am concentration increase." The reviewers found this response to be acceptable. The following describes in more detail the evaluation of unmitigated and mitigated consequences.

(a) **Unmitigated Consequences –** Unmitigated consequence severity level calculations (24590-HLW-Z0C-W14T-00013) were performed for liquid spills, liquid sprays, canister drops, drum drops, molten glass spills, and crush impact of a HEPA filter. The reviewers evaluated the specific scenarios analyzed for the HLW facility that affected the basemat design, the assumptions used, and the results of the unmitigated consequence calculations. The reviewers determined that the unmitigated consequence calculations for the postulated accident sequences were acceptable according to Section 4.3.1 of Appendix A of the SRD for the following reasons: (1) consequences accounted for type, form, and quantity of radioactive material and the energy sources available to interact with the hazardous material, (2) no credit was taken for mitigative or preventive controls, and (3) the consequences were evaluated for ground level releases.

(b) **Mitigated Consequences –** The PCAR contained mitigated DBE evaluations of two DBEs: (1) liquid spills due to vessel failure and (2) canister drops. (See Item 6 below for further identification of these DBEs.) The description of the events included the initial control strategy, source term, frequency and consequence estimates, comparisons of estimated mitigated consequences to the radiation exposure standards of SRD Safety Criterion 2.0-1 and target frequencies, discussion of final control strategy (credited mitigative and preventive features), and defense in depth considerations. In addition to these two DBE analyses, reviewers evaluated calculations 24590-HLW-U4C-U78T-00001, *Liquid Spills*, and 24590-HLW-Z0C-30-00001, *High Level Waste Canister Drops*. The reviewers concluded that the appropriate methodology, data, and assumptions were used in the analyses. The analysis results, consisting of final control strategy selection, mitigated consequences with the credited mitigative and preventive controls, and compliance with SRD Appendix A criteria for meeting the radiation exposure standards of SRD Safety Criterion 2.0-1 and target frequency (initiating event combined with failure of credited controls) were acceptable. The reviewers considered the estimation of mitigated accident consequences for the liquid spills and canister drop DBEs to be acceptable according to the requirements of SRD Safety Criterion 4.3-2.

As described in calculation report 24590-HLW-DBC-S15T-00001, BNI analyzed canister drops at 10 locations of which 3 were credible. Of the 3 credible canister drops analyzed, 2 were determined to have no detrimental impact while one caused damage to the basemat. An impact absorber was specified to mitigate canister drops to prevent damage to the basemat. This was acceptable to the reviewers.

In response to reviewer questions, BNI identified a single 100 L glass spill event that was considered credible and could have a detrimental effect on the structural integrity of the basemat or the embedded C5 ventilation duct but did not provide a detailed analysis that was required for a DBE. Calculation report 24590-HLW-U0C-30-00002 analyzed a 100 L glass spill onto the floor of the pour tunnel. Because the calculation showed that the embedded C5 ventilation duct could reach a temperature of 161°F, a structural evaluation (24590-HLW-S0C-S15T-00016) was performed on the basemat and C5 ventilation duct. The structural evaluation concluded that the impacts from a 100 L spill in the pour cave were acceptable. The reviewers agreed with this conclusion.

In response to Questions HLW-PCAR-012, a second glass spill[78] was analyzed. This spill was postulated to result from failure of the melter shell where the entire volume of the melter spills onto the floors of the melter cave and pour tunnel along with a failure of the melter cooling system that allows the cooling water to pour onto the hot glass surface at a rate of 50 gpm. The purpose of this calculation was to evaluate the amount of steam condensate (water) created by the interaction of the cooling water and the hot glass. The calculation estimated the accumulation of condensate in a low point of the embedded C5 ventilation duct between the pour tunnel and the walkway to the drum transfer tunnel and the effect on the HEPA filters. The calculation concluded that such a spill would not block the embedded C5 ventilation duct because the total accumulation of condensate in the low section of the embedded duct was less than 212 L, which is about 7% of the total volume of the lower duct. In addition, the temperature and humidity in the C5 ventilation duct following the glass spill does not exceed the limitations of the environmental conditions for the HEPA filters. The reviewers agreed with this conclusion.

The reviewers questioned whether larger spills than considered above in the

[78] BNI calculation report 24590-HLW-U0C-30-00001, *HLW-Melter Glass Spill Transient Calculation Using HADCRT Computer Code*.

response to Question HLW-PCAR-012 were credible. After further study, BNI concluded that a 2700 L inadvertent pour of glass (described further in the next paragraph) was also a DBE.

This spill consisted of an inadvertent pour of 2700 L of glass, approximately 40% of melter volume, into a 2 ft wide by 8 ft long by 6 ft deep catch pan which was mounted six inches above the pour tunnel floor. The section of the embedded C5 ventilation duct, which is routed from the pour tunnel floor to the drum transfer tunnel, was not credited as providing a safety function in the hazard analysis in calculation report 24590-HLW-U0C-30-00003, Rev. B. The calculation was revised (as Rev. C) to include the inadvertent melter pour with the C5 ventilation duct blocked. Also, BNI calculation report 24590-HLW-U0C-30-00001 showed that this portion of the C5 ventilation system could be blocked as a result of a glass spill accident without adverse consequences. Specifically, if the 36-inch embedded exhaust duct became blocked, the minimum required airflow from the pour cave would be provided by the portion of the C5 ventilation system serving the melter cave through the cave openings.

In response to Question HLW-PCAR-012 concerning structural modeling of the C5 ventilation ductwork, BNI stated that the design basis glass spill of 2700 L could be accommodated by the controls to be credited (insulation, catch pan under pour spout) without imposing any additional functional requirements on the basemat and embedded ductwork than were already credited in the PCAR and responses to reviewer questions.

On the basis that the 100 L molten glass spill DBE consequences are less severe, the reviewers found that detailed analysis of the 2700 L molten glass spill DBE is a condition of acceptance of the HLW PCAR. The analysis must be completed before authorization of full HLW facility construction.

4. **Estimating Accident Frequencies** – The reviewers found the approach to estimating accident frequencies to be acceptable. The reviewers evaluated Chapter 3 and the CSD records in Appendix A of the submittal and the results of the hazard analysis in 24590-WTP-RPT-TE-01-002. The reviewers evaluated results of the frequency determinations, based on methodology described in report 24590-WTP-GPP-SANA-002C for the potential accident/event sequences associated with the hazards from the processes, design and operations that could affect the basemat.

   (a) **Frequency of Unmitigated Accidents –** The reviewers found the description of unmitigated accident frequency to be acceptable. While the overall facility is unique, the DBE initiating events of concern, i.e., leaks, spills, and canister drops, are common industrial events for which historical information concerning frequency of occurrence is available. The unmitigated frequency selection took into consideration the BNI-specified enhanced reliability requirements for the hoisting and rigging equipment and the melter design. The submittal identified CSD records for basemat-affecting hazards, including their initiating event frequencies, which had the potential to produce radiological consequences above SL-4 and chemical consequences above threshold. A component reliability database of available industry data was compiled from a number of sources, including AIChE's Center of Chemical Process Safety, the Westinghouse Savannah River Company, EG&G Idaho, Inc., the International Atomic Energy Agency, and the Institute of Electrical and Electronics Engineers. This database was used for estimating initiating event frequencies.

(b) **Frequency of Mitigated Accidents –** The reviewers found the description of mitigated accident frequency to be acceptable. For the analyzed DBEs, the selected final control strategies were mitigative rather than preventive. Therefore, the mitigated frequency of the accident sequences was the same as the initiating event or unmitigated accident frequency.

(c) **Target Frequency –** The reviewers found acceptable the description of the degree to which the target frequency was achieved. A release of radioactivity above limits cannot occur unless the mitigative controls credited for an accident fail on occurrence of the initiating event. Because system air pressure depression or filtration provided by the C5 ventilation system is the active mitigation credited for meeting the radiation exposure standards of SRD Safety Criterion 2.0-1 for all the analyzed DBEs, BNI used calculation, 24590-HLW-U3C-C5V-00001, *HLW C5 System Preliminary Design System Models*, to demonstrate that the frequency of the release for the SL-1 events was $<10^{-6}$ per year, as required by the SRD, Appendix A, Section 5.0, "Development of Control Strategies." Reviewers evaluated this calculation and agreed with the conclusion.

5. **Considering Common-Cause and Common-Mode Failures** – The reviewers found the selection of common-cause and common-mode failures to be acceptable, as described in Section 3.3.4 and the CSD records in Appendix A of the submittal and the results of the hazard analysis in 24590-WTP-RPT-TE-01-002. The evaluation reviewed the description of credible common-cause events that could affect the safety functions of the basemat and embedded C5 ventilation ductwork. This evaluation included considering natural phenomena events, external manmade events, loss of electrical power, fire, internal missiles, and internal flooding.

   Section 3.3.4 considered two of three broad categories of dependencies to classify and define the common-cause failures that were expected to be important: functional dependencies, spatial dependencies, and institutional dependencies (deferred until a later PSAR submittal). Each represented a functionally different way in which commonalties between redundant systems, trains, or components could potentially reduce the overall expected reliability.

   Functional dependencies reflected the reliance of multiple systems, trains, or components on a single system, train, component, or process condition. This was evaluated to ensure that the reliance of ITS SSCs on other active support systems was recognized and failure modes of these support systems were evaluated to ensure that the ITS SSCs could still perform their associated safety functions. The PCAR determined that the basemat did not functionally depend on active SSCs performing their safety functions because the basemat had a passive safety function.

The internal DBEs for which analyses were included in the PCAR (e.g., liquid spills and canister drops) credited the embedded C5 ventilation system for protecting workers; therefore, a functional dependency of this exhaust system on the offsite power system was involved. This functional dependency was addressed by accounting for the loss of power in calculating the reliability of the C5 ventilation system needed to meet the target frequency criteria. The reviewers found this treatment of dependency to be acceptable.

Spatial dependencies determine the impact of failure of two components as a result of their co-location in an area that experiences the effects of (1) internal fires or explosions; (2) internal floods from failed tanks, cooling systems, etc.; (3) externally applied forces and loads from seismic activity, airplane crashes, vehicle crashes, etc.; and (4) natural forces and environmental stressors, e.g., severe weather, lightning, floods, and external fires. Defense against spatial dependencies comes from hardening or protecting each component to make it less vulnerable to the specific hazard of concern and from physical separation to minimize the likelihood of multiple failures from a single casualty.

The PCAR evaluated the impacts from the above external initiators on the basemat and concluded that the FRE for the basemat would be classified as SC-I for seismic events and PC-3 for externally applied natural forces to prevent the occurrence of multiple identified SL-1 events as a result of the seismic DBE or other NPH as a common-cause event. The PCAR also concluded that the basemat's passive safety function was not impacted by internal events, such as fires or flooding. The FRE for the basemat will support the required safety functions of structurally supporting the HLW vitrification systems and processes and enabling the facility to be placed in a safe state. The reviewers agreed with this conclusion.

Spatial dependencies were adequately considered in analyzing the seismic DBE by assuming that all SC-III/IV SSCs will fail and by including the effects of earthquake-induced fires.

The PCAR did not address institutional dependencies because these will be evaluated in the PSAR, e.g., qualification for intended service, or in the FSAR as administrative or management controls. The reviewers found this to be acceptable.

6. **Defining DBEs** – The reviewers found the set of DBEs identified for the basemat to be conditionally acceptable. Based on the ISM process, the selection of internal DBEs for HLW, including those not affecting the basemat, was described in 24590-WTP-RPT-TE-01-002. For liquid spills, the PCAR selected the failure of a HLW concentrate receipt vessel[79] as the bounding or worst case accident, with SL-1 unmitigated consequences to

[79] CSD-H100/N0016 in the submittal, renamed CSD-HHCP/N0007 based on a comparison of the description of the initiator, the hazardous situation, and the control strategy elements.

the facility and co-located workers and SL-3 for the public. For molten glass spills, one molten glass spill DBE was identified with the potential to affect the basemat's design. The event, CSD-H210/N0001, was catastrophic failure of the melter cooling, resulting in a loss of the thermal boundary and a leak of molten glass. Three limiting DBE canister drops were selected: (1) drop of an unlidded canister in a C5 ventilation area (CSD-H310/N0023), (2) canister drops in a C3 ventilation area (CSD-H340/N0010), and (3) drop of the canister in the export cask area (CSD-H340/N0020).

The reviewers found the identified set of internal basemat-affecting DBEs to be acceptable. The submittal sufficiently summarized the accident sequences identified in the hazard analysis. However, as noted in Item 3 above, "Estimating Accident Consequences," the detailed analyses of both the 100 L and the 2700 L molten glass spill DBE were missing and the 2700 L molten glass spill DBE must be provided to DOE before authorization of full HLW facility construction, as a condition of acceptance of the HLW PCAR. The identified sequences contained sufficient detail to provide an adequate basis for estimating each accident’s consequences and frequency. Each had consequences of at least SL-1, -2, or -3 as defined in the SRD, Appendix A. The reviewers also found that Chapter 3 and Appendices A and C of the submittal, along with the referenced calculations, provided (a) comprehensive and credible accident sequences that identified initiating events with their prevention and mitigation measures, and other contributing phenomena and (b) the rationale for sorting hazardous situations into accident groups or categories (e.g., liquid spills and chemical reactions).

Given the limited experience with melter operations, BNI analyzed two accidents beyond the assumptions of the DBEs in response to Question HLW-PCAR-012 to offer perspective on the consequences of large molten glass spills. The first analysis, calculation 24590-HLW-U0C-30-00003, *Analysis of HLW Melter Unplanned Pour Using HADCRT Computer Code*, Rev. B, involved the inadvertent pour of 2700 L of molten glass into a 2’ wide x 6’ high x 8’ long catch pan, mounted 6" off the pour tunnel floor, with an additional 4000 L of molten glass spilling to the center of the pour cave floor. This case maximized the pour cave wall temperatures as well as the pressure transient in the pour cave. The maximum concrete wall surface temperature was less than 250°F. The peak pressure in the pour cave was less than eight inches of water, which did not significantly impact the cascade airflow. The second beyond DBE, calculation 24590-HLW-U0C-30-00003, Rev. A, was an evaluation based on a 6600 L glass spill into a 6’ wide x 6’ high x 7’ long catch pan, which sits directly on the pour tunnel floor. This case maximized the pour cave basemat temperature. The maximum concrete floor surface temperature was less than 350°F after 10 days and remained below ACI 349-01 code limits for over 10 days following the event.

The effects of both beyond DBE molten glass spills were limited to small regions of the HLW facility. Further qualitative evaluation of the beyond DBE molten glass spills was performed by BNI and showed the beyond DBEs did not adversely impact the capability to safely evacuate the workers and public in the vicinity of the WTP within 24 hours following the spill because the structural and confinement safety functions provided by the building and C5 ventilation system would remain intact.

For external DBEs, the reviewers found the information on design of the basemat to be conditionally acceptable. The PCAR provided information, supplemented by the responses to questions relative to design and analysis of the basemat and interfacing walls, including other external facility phenomena and events (e.g., wind, missiles due to wind, flooding, volcanic ash, snow, and postulated aircraft crashes). The PCAR provided acceptable information for seven of the eight information areas identified in Section 4.6.3.3.1 of RL/REG-99-05. Evaluation of the information for each area is summarized below:

(a) **Seismic DBEs**

(i) Seismic Performance Categorization – The reviewers found acceptable the classification of the HLW facility structures, including the basemat and wall connection, as SC-I based on their SDC classification and the necessity that they function during a seismic event. The reviewers found this acceptable because it was consistent with the requirements of SRD Safety Criterion 4.1-3.

(ii) Selection of Seismic Design Criteria, Seismic Hazard Curve, and Seismic Response Spectra – The reviewers found the analysis methods and design criteria, which were consistent with or more conservative than those in DOE-STD-1020-94, ASCE 4-98, and SRD Safety Criterion 4.1-1, to be acceptable. The seismic hazard curve was based on a 1996 site-specific study performed by Geomatrix for the Hanford site. The study was reviewed and accepted earlier by the OSR.[80] In 1999, the study was subsequently validated by BNI personnel as members of the Tank Waste Remediation System Privatization Team. The reviewers found the peak ground acceleration of 0.26 g and the DBE response spectra for the HLW facility acceptable because they were consistent with the site-specific hazard curve and SRD Safety Criterion 4.1-3.

(iii) Seismic Analysis and In-Structure Spectra Development Methodology – The reviewers found the seismic analysis and in-structure spectra development methodology to be acceptable. BNI performed seismic analysis of the HLW building considering the effects of soil-structure interaction during the design basis earthquake using methods that were consistent with DOE-STD-1020-94, ASCE 4-98, and SRD Safety Criterion 4.1-3. The design basis seismic loads for the basemat were calculated using the accelerations from the soil-structure interaction analysis and a method that was conservative and therefore acceptable to the reviewers. The reviewers found the method for developing the in-structure spectra for building supported SSC design to be acceptable

[80] 99-RU-0394, letter, D.C. Gibbs, OSR, to M.J. Lawrence, BNFL, "Acceptance of Peak Ground Acceleration (PGA) for the RPP-P Facility Design Basis Earthquake," dated June 30, 1999.

because it was consistent with the requirements of DOE-STD-1020-94 and ASCE 4-98.

(iv) Seismic Acceptance Criteria – The reviewers found the seismic acceptance criteria to be acceptable. The submittal evaluated or referenced the design adequacy of the HLW basemat by calculating demand/capacity ratios using section capacities based on ACI 349-01 code provisions. The reviewers found this method to be acceptable because it was consistent with DOE-STD-1020-94 and SRD Safety Criterion 4.1-3. In response to Questions HLW-PCAR-127 and -131 concerning demand/capacity ratios, BNI tabulated the demand/capacity ratios at the basemat's critical and highly stressed locations for the critical load combinations including seismic loads. Because the highest demand/capacity value in this table was <1.0, the reviewers found the basemat structural design to be acceptable from seismic considerations, especially because the code permissible capacity was reduced by 15% to create a source of reserve capacity. Initially, BNI did not submit similar tables listing the demand/capacity ratios for the basemat-to-wall-connections that are essential to establish the seismic design adequacy of the dowels that will make the basemat and the wall monolithic, a fundamental design and analysis assumption. However, in response to Question HLW-PCAR-131, BNI provided similar tabulated values of demand/capacity ratios for the critical and highly stressed basemat-to-wall connections. These values established the adequacy of these connections to withstand the combined shears and moments from seismic and other loads.

(v) Seismic Detailing and Anchorage Design – The reviewers found the commitment to detail the reinforcing steel in the HLW basemat according to ACI 318-99, Chapter 21, to be acceptable because it was consistent with SRD Safety Criterion 4.1-3. BNI performed or referenced generic designs of anchorage in basemat concrete using criteria and methods in ACI 349-01.

(vi) Evaluation of the Consequences of Beyond-the-Design-Basis Earthquake – The reviewers found the evaluation of the consequences of beyond-the-design-basis earthquake to be conditionally acceptable. BNI completed a seismic probabilistic risk assessment to determine if the consequences of the HLW facility failing due to a beyond-the-design-basis earthquake would meet the radiation exposure standards in SRD Safety Criterion 2.0-1. The results of the preliminary seismic study, summarized in Section 3.6 of Volume IV of the PCAR, show that the seismically induced radiological releases from the HLW facility meet these requirements for the workers, co-located workers, and the public. However, BNI has not yet determined the combined effects of seismically induced radiological releases from the PT, LAW, and HLW facilities. As such, BNI must complete the seismic probabilistic risk analysis, demonstrating compliance to the radiation exposure standards of SRD Safety Criterion 2.0-1 before authorization for full facility construction (excluding the Analytical Laboratory) as a condition of acceptance of the PCAR.

(vii) Seismic Calculation Methods – The reviewers found the methods for calculating the seismic loads and designing the basemat for these and other loads to be acceptable because the methods were consistent with the requirements of DOE-STD-1020-94, ASCE 4-98, and SRD Safety Criterion 4.1-3.

(viii) Safety and Operability Functions of the Basemat – The reviewers found the description of the basemat's safety and operability functions to be acceptable. The basemat provides structural support to the rest of the building, including all ITS and non-ITS SSCs during normal operations and during abnormal events and DBEs, including the design basis earthquake. The reviewers found this functional requirement of the basemat to be acceptable. The submittal also assumed that the basemat acts as a secondary barrier against leakage of radioactive fluid into the foundation soil. Even though the PCAR did not establish any explicit quantitative criteria to evaluate the basemat's effectiveness in acting as a secondary barrier, the evaluation of heavy canister drop onto the basemat indirectly shows that it assumed the basemat to be an effective barrier because its deformation state satisfies the ACI 349-01 limits for impactive and impulsive loads. The reviewers found the accident-related functional requirement to be acceptably met.

(b) **Other External DBEs** – The reviewers found the information on the design of the basemat for other DBEs, as provided in the PCAR, Volume IV, and other documents referenced therein acceptable for 5 of the 6 criteria, with one criterion not applicable. The reviewers evaluated the six considerations described in Section 4.6.3.3.2 of the RL/RG-99-05. The reviewers' evaluations are summarized below:

(i) The reviewers found the selection of the PC-3 design basis wind as well as the calculation methodology acceptable because they were consistent with the requirements in DOE-STD-1020 and Table 4-1 of SRD Safety Criterion 4.1-3. In BNI's calculation report 24590-HLW-S0C-S15T-00018, *HLW Environmental, Dead, and Live Loads,* BNI used a design wind speed of 111 mph. BNI used ASCE 7-98 methodology to calculate pressures resulting from the design basis wind.

(ii) Reviewers found the selection of the design basis wind-driven missile and the calculation methodology acceptable because they were consistent with the requirements of DOE-STD-1020 and Table 4-1 of SRD Safety

Criterion 4.1-3. The wind-driven missile load was not pertinent to the basemat design because the basemat is deep in the ground. In Section 2.4.3.6 of Volume IV of the PCAR, BNI indicated that the HLW building was being designed for a 15-lb timber plank missile with a velocity of 50 mph, striking the facility at 30 ft above the grade.

(iii) The reviewers found BNI's statement that river flooding was not applicable for the HLW building to be acceptable because, as stated in Section 2.4.3.13 of the PCAR, the HLW building is located about 150 ft above the maximum postulated flood level.

(iv) The reviewers found the selection of the design basis ashfall loading of 12.5 lb/ft^2 for a PC-3 facility (per 24590-HLW-S0C-S15T-00018) and its application in HLW design acceptable because they were consistent with Table 4-1 of SRD Safety Criterion 4.1-3. BNI considered ash loading concurrent with roof live loading and showed that the facility met the applicable design requirements for withstanding loading due to ashfall.

(v) The reviewers found the selection of the design basis snow load of 15 lb/ft^2 (per 24590-HLW-S0C-S15T-00018) and its application in HLW design acceptable because they were consistent with Table 4-1 of SRD Safety Criterion 4.1-3 and ASCE 7-98. BNI considered snow loading not to be concurrent with roof live loading but showed that the facility met the applicable design requirements for withstanding loading due to snow.

(vi) An evaluation was completed of a postulated accidental aircraft crash into the WTP facilities (24590-WTP-Z0C-50-00001). The evaluation concluded that the frequency of an aircraft crash with enough energy to result in a release from the WTP was <1 x 10^{-6}/yr. In response to Question LAW-PCAR-068 concerning an aircraft crash, BNI stated that the postulated airplane crashes onto the LAW and HLW buildings would not affect the basemat because such loads were judged not to impact the basemat structural integrity. Reviewers found this acceptable.

7. **Defining the Operating Environment –** The reviewers found the description of operating environment for the HLW basemat acceptable. The operating conditions under which the identified ITS SSCs (the basemat and C5 ventilation ductwork) must function were found to not be significantly affected by either the internal or external DBEs. The molten glass spill DBE causes a more severe operating environment than normal in the pour cave. However, as described in BNI's response to Question HLW-PCAR-012 concerning the glass spill event, such a spill does not prevent the basemat or the C5 ventilation system from performing their credited safety functions. As noted previously in Item 3(b), "Mitigated Consequences," above, BNI must include the DBE analysis for the 2700 L molten glass spills in the first revision of the PSAR after authorization for construction.

8. **Identifying Potential Control Strategies** – The reviewers found the identification process of potential control strategies to be conditionally acceptable. The HLW PCAR identified the basemat and the embedded C5 ventilation ductwork with the safety functions described below as the final control strategies for mitigating the basemat-affecting DBEs. The PCAR characterized the safety functions of the HLW basemat as follows:

- "The HLW vitrification facility basemat is credited for secondary confinement of liquids in conjunction with the cell, cave or tunnel walls, and sumps, for anchorage of process equipment, and for providing protection of embedded process systems."[81]

- "The safety functions of the basemat and the basemat in conjunction with the cell, cave, or tunnel walls, and sumps is (sic) to ensure confinement of radioactive materials during normal, abnormal, or accident conditions and to enable placing and maintaining the facility in a safe state."[82]

Part of the C5 ventilation system ductwork is embedded in the HLW basemat. The hazards and accident analysis in the HLW PCAR assessed the safety functions performed by the C5 ventilation and exhaust system in support of the overall HLW facility safety functions. BNI characterized the safety functions of the C5 ductwork as follows:

- "The safety functions of the C5 ventilation system ductwork is (sic) to 1) ensure confinement of radioactive materials during normal, abnormal, and accident conditions and 2) enable placing and maintaining the facility in a safe state."[83]

The analyses of internal DBE (liquid spills and canister drops) and the external DBE (the design basis seismic event), identified safety functions that were shown to be necessary and sufficient to meet the radiation exposure standards of SRD Safety Criterion 2.0-1 and the target frequency for SL-1 events.

The reviewers evaluated Sections 3.3 and 3.4 and the CSD records in Appendix A, including control strategy elements and safety case requirements identified in the CSD records, in the HLW facility-specific submittal and the results of the selection of hazard control strategies for DBEs in 24590-WTP-RPT-TE-01-002. The evaluation focused on the description of the potential hazard control strategies that were identified to manage potential accidents associated with the processes, design, and operations that could affect the basemat or the embedded C5 ventilation duct as well as the final control strategies selected for the analyzed DBEs.

[81] CCN: 024490, letter, A.R. Veirup, BNI, to M.K. Barrett, ORP, "Contract No. DE-AC27-01RV14136 – Request for Review and Approval of the Partial Construction Authorization Request for the Hanford Tank Waste Treatment and Immobilization Plant," Attachment 2, Item 3, dated December 10, 2001.
[82] 24590-WTP-PSAR-ESH-01-001-04, Section 4.3.1.1, "SDC Safety Function," p. 4-1.
[83] 24590-WTP-PSAR-ESH-01-001-04, Section 4.3.1.1, "SDC Safety Function," p. 4-3.

The DBE analyses in Chapter 3 of the submittal listed the initial control strategy elements for the liquid spill and canister drop internal DBEs and the seismic DBE. In addition to the structure and the C5 ventilation system, the control strategies included several that did not affect the basemat design. The final control strategies selected for basemat-affecting DBEs also credited the structure and the C5 ventilation system as an air pressure depression for the facility worker, and a filtration function (of decontaminating accidental releases) for the co-located worker and the public. Based on BNI's DBE calculations in the reports, 24590-HLW-U4C-U78T-00001 and 24590-HLW-Z0C-30-00001, and the C5 system ventilation reliability calculation in the report 24590-HLW-U3C-C5V-00001, reviewers determined that the selected final control strategies met the radiation exposure standards of SRD Safety Criterion 2.0-1 and target frequency requirements of the SRD, Appendix A. In response to Question HLW-PCAR-012 concerning the glass spill, BNI demonstrated that the same control strategies were sufficient for mitigating the molten glass spill DBE. Reviewers found the control strategy selection for accidents impacting the basemat and C5 ventilation system design acceptable with the condition, noted previously (Section 4.2.2.2, Item 3b of this SER) that BNI must provide to DOE the 2700 L molten glass spill DBE analysis before authorization for full HLW facility construction.

9. **Documenting the Hazard Evaluation** – The reviewers found the documentation of the facility hazard evaluation of the basemat acceptable. Pursuant to SRD, Appendix A, Section 4.9, "Documentation," the reviewers evaluated the documentation of the HLW facility hazard evaluation as presented in Chapter 3 and in the CSD records in Appendixes A and C of the submittal and in 24590-WTP-RPT-TE-01-004. Based on this evaluation, documentation of the hazard and accident analysis results was acceptable and consistent with the current status of the facility and process design.

4.2.2.3 Conclusions

The reviewers concluded that the results of HLW facility hazard and accident analysis were conditionally acceptable. The reviewers also concluded that the hazards information, as supplemented by information in responses to OSR questions and BNI calculations, was consistent with the current status of the facility and process design. The reviewers determined that the submittal, with exceptions identified below, enabled the OSR to determine that the radiological, nuclear, and process hazards associated with facility operation, including those from postulated accidents, had been adequately assessed and that sufficient preventive or mitigative features had been identified.

Conditions of Acceptance – BNI must complete the following actions and provide to DOE before authorization of full HLW facility construction (not including the Analytical Laboratory).

1. Provide the DBE analysis of the 2700 L molten glass spill accident.

2. Submit an evaluation of the combined effects of seismically induced radiological releases from the PT, LAW, and HLW buildings on the workers, co-located workers, and the public through a seismic probabilistic risk analysis study.

4.2.3 HLW Important-to-Safety SSCs

The purpose of this review was to determine whether the submittal adequately identified the basemat ITS SSCs and the most severe anticipated conditions under which they must function for the HLW vitrification facility PCAR.

4.2.3.1 Requirements

The general requirements for the HLW basemat ITS SSCs were the same as those listed in Section 3.4.1 of this document but as applied to the HLW basemat. The submittal for the basemat must identify the most severe environmental conditions under which HLW basemat-related ITS SSCs must function, including temperature, pressure, humidity, radiation level, and chemical environment.[84] The hazard control strategies selected must be shown to be consistent with the most severe identified environmental conditions. The operating environment during normal operations and under off-normal and accident conditions, as it would affect the HLW basemat design-related ITS SSCs, should be considered in determining hazard control strategies.

The reviewers evaluated whether BNI adequately determined and documented each HLW basemat-affecting ITS SSC, using the six elements described in Section 3.4.1[85] of this SER: (1) SSC identification, (2) safety function, (3) system description, (4) functional requirements, (5) system evaluation, and (6) controls (TSRs).

4.2.3.2 Evaluation

The reviewers found the identification of HLW SSCs related to the basemat to be acceptable. The BNI methods and selection criteria for ITS SSCs were discussed in Section 4 of Volume I, *General Information*, of the submittal as discussed in Section 3.4 of this SER. Section 4 of Volume IV of the submittal identified two SDC HLW SSCs related to the basemat for the facility that were required to provide the necessary preventive or mitigative functions in the accident analysis to meet the radiation exposure standards defined in SRD Safety Criterion 2.0-1. These SSCs were the HLW basemat and portions of the C5 area ventilation exhaust system and are evaluated separately below.

HLW Basemat – The reviewers found five of the six criteria to be acceptably met and one to be not relevant to construction of the basemat. The evaluation of the information for each review

[84] SRD, Appendix A, Section 4.7, "Definition of Operating Environment."
[85] RL/REG-99-05, Section 4.5.3.3.3, "Regulatory Acceptance Criteria."

criterion is summarized below:

1. **SSC Identification** – The reviewers found the HLW basemat identification to be acceptable because it appropriately identified and documented the basemat as an SDC SSC in Sections 4.3 and 4.3.1 of Volume IV of the submittal. The reviewers agreed with this identification because the basemat provided structural support for the C5 ventilation exhaust system as required by the review criteria described in Section 3.4.1 of this SER.

2. **Safety Function** – The reviewers found the basemat's safety function identification to be acceptable. Section 4.3.1.1 of Volume IV of the submittal identified that, in addition to supporting the C5 ventilation exhaust system, one of the safety functions of the HLW basemat and the HLW basemat in conjunction with the cell, cave, tunnel walls, and sumps, was to ensure that radioactive materials were confined during normal, abnormal, and accident conditions. Another important safety function of the HLW basemat was to allow the facility to be placed and maintained in a safe state. The reviewers agreed with the definition of safety functions for the HLW basemat. In BNI's response to Questions HLW-PCAR-104 and -110 through -115 concerning safety functions of the basemat, the reviewers determined that, as part of its confinement safety function (i.e., secondary physical barrier), the HLW basemat was designed to minimize any potential leaks due to cracking in areas associated with liquid storage or decontamination activities. BNI assumed that HLW basemat cracks could be <1/32-inch wide and uniformly distributed due to thermal expansion and contraction. These cracks would provide a tortuous path for liquids to travel to the soil column; therefore, any release would be "non-detectable." Although no standards were identified for leaks to the soil column from cracks or seams in the HLW basemat, BNI did a qualitative evaluation of potential doses to the public and concluded that any releases through the HLW basemat would be expected to have minimal radiological impacts because the radionuclides would be confined to the soil immediately beneath the HLW basemat, far from contact with the co-located worker or members of the public. Because BNI anticipated "non-detectable" leakage from normal operations, the only potential release of radionuclides through the HLW basemat would be from serious damage to the basemat following an impact (e.g., a canister drop) event (CSD-H310/N0023). The reviewers considered this response to be acceptable and agreed with the conclusions concerning the SSCs' required safety functions. BNI did not consider airborne material leaks through cracks or seams in the basemat. The reviewers agreed that such leaks, if any, would be so small that the SDC C5 ventilation system would prevent any leakage through the cracks and seams.

3. **System Description** – The reviewers found the PCAR description of the basemat to be acceptable. Section 4.3.1.2 of Volume IV of the submittal adequately described the construction of the HLW facility basemat consistent with the review criteria. In response to Question HLW-PCAR-105 concerning analyses of the HLW basemat, the reviewers determined that numerous structural analyses were conducted in support of the conclusions that the design of the HLW basemat was adequate to meet the required safety functions. (See, however, Section 4.2.1 concerning HLW facility description for further discussion, and a condition requiring transient CFD analysis of the thermal effects of a 2700 L DBE glass spill.)

4. **Functional Requirements** – The reviewers found the description of the functional requirements of the HLW basemat to be acceptable. Section 4.3.1.3 of Volume IV of the submittal adequately described the HLW basemat's functional requirements: (1) provide structural support of the HLW vitrification facility SSCs during normal or abnormal conditions, including embedded process equipment, (2) withstand design basis accident conditions, and (3) provide secondary confinement of liquids. In addition, the reviewers determined that the basemat provided an adequate secondary barrier to radiological gases, as discussed in Item 2 above. No specific safe state functional requirements were identified. The reviewers determined that the functional requirements were established by applying the DBE analysis process, provided in Section 3.4.2.1 of Volume IV of the submittal, and the identification of hazards affecting the HLW basemat design, provided in Appendix C of the submittal. The reviewers determined that BNI appropriately committed to designing the HLW basemat to meet relevant SRD safety criteria, including Safety Criteria 4.1-2, 4.1-3, 4.1-5, and 4.2-1.

5. **System Evaluation** – The reviewers found the description of the system evaluation for the HLW basemat to be acceptable. Section 4.3.1.5 of Volume IV of the submittal adequately described the HLW basemat. BNI committed that the applicable SRD codes and standards listed in the preceding paragraphs ensured that radioactive materials are confined, provided for anchorage or embedments for process equipment, and protected embedded systems.

6. **Controls (TSRs)** – The reviewers found acceptable the conclusions in Section 4.3.1.6 of Volume IV of the submittal that no TSRs were required for the basemat. The reviewers found this acceptable because BNI did not identify any safety limits or other restrictions relative to the HLW basemat performance that could cause a direct release of unacceptable levels of radioactive materials that would expose workers or members of the public in excess of any standards.

C5 Area Ventilation Exhaust System (portions embedded in the basemat only) – The reviewers found five of the six criteria to be acceptable and one to be not relevant to the construction of the basemat. The evaluation of the information for each review criterion is summarized below:

1. **SSC Identification –** The reviewers found the identification of the embedded portion of the C5 exhaust ventilation system to be acceptable. Sections 4.3 and 4.3.2 of Volume IV of the submittal stated that the HLW C5 area ventilation exhaust system was an SDC SSC as required to meet the radiological exposure standards defined in SRD Safety Criterion 2.0-1. The reviewers agreed with this identification.

2. **Safety Function –** The reviewers found the description of the safety function of the embedded portion of the HLW C5 area ventilation exhaust system to be acceptable. Section 4.3.2.1 of Volume IV of the submittal identified that the safety functions of the HLW C5 area ventilation exhaust system related to the basemat were to (1) ensure confinement of radioactive materials during normal, abnormal, and accident conditions and (2) enable placing and maintaining the facility in a safe state. The evaluation was

limited to safety functions associated with the basemat portion of the C5 ventilation system only. The reviewers agreed with the safety functions identified by BNI for the HLW C5 area ventilation exhaust system.

3. **System Description –** The reviewers found the system description of the construction of the embedded portion of the HLW C5 area ventilation exhaust system to be acceptable. The reviewers evaluated the C5 ventilation system description provided in Section 4.3.2.2 of Volume IV of the submittal relative to basemat features and determined that the design showed a portion of the C5 ventilation system ductwork embedded in the HLW basemat. The design called for the embedded portion to be constructed of welded stainless steel pipe to reduce the potential for corrosion. The ductwork was designed to have a 36-inch diameter and have a minimum cover of two feet of reinforced concrete.

4. **Functional Requirements –** The reviewers found the description of the functional requirements of the basemat embedded portion of the HLW C5 area ventilation exhaust system to be acceptable. Section 4.3.2.3 of the submittal identified the purpose of the C5 area ventilation system functional requirements: (1) to confine aerosols and (2) to maintain cascade airflow. The submittal indicated that the ductwork was required to provide unrestricted airflow from process areas to the HEPA filters and withstand a caustic environment up to a pH of 13.95. The functional requirements were established by applying the DBE analysis process. The hazards affecting the HLW basemat design were described in Appendix C of Volume IV of the submittal. In response to Question HLW-PCAR-109 concerning the performance of the C5 area ventilation exhaust system, BNI provided calculation report 24590-HLW-U0C-30-00001, which showed that the potential accumulation of condensed water in the ductwork, which may cause blockage of the airflow, would not affect the safety function of the C5 ventilation system under normal and accident conditions. Finally, the reviewers determined that BNI acceptably committed to design the HLW C5 ventilation exhaust system to meet relevant SRD safety criteria, including Safety Criteria 4.1-2, 4.1-5, 4.2-1, and 4.2-2.

5. **System Evaluation –** The reviewers found the evaluation for the embedded portion of the HLW C5 area ventilation exhaust system to be acceptable. Section 4.3.2.5 adequately described the basemat portion of the HLW C5 area ventilation exhaust system. The PCAR indicated that the proposed design of the HLW C5 area ventilation exhaust system would (1) ensure confinement of radioactive materials during normal, abnormal, and accident conditions and (2) enable placing and maintaining the facility in a safe state.

6. **Controls (TSRs) –** The reviewers found the conclusions in Section 4.3.2.6 of Volume IV that no TSRs were required for the embedded portion of the C5 area ventilation exhaust system to be acceptable. This conclusion was acceptable because the PCAR did not identify any safety limits or other safety assumptions relative to the loss of the embedded portion of the HLW C5 ventilation exhaust system that could cause a direct release of unacceptable levels of radioactive materials that would expose workers or members of the public in excess of any standards.

4.2.3.3 Conclusions

The reviewers concluded that (1) the PCAR acceptably identified ITS SSCs, specifically the basemat and the embedded portions of the C5 ventilation exhaust system, to implement the hazard control strategies for the HLW basemat; (2) Volume IV of the submittal provided acceptable documentation of the HLW basemat and the embedded portion of the C5 area ventilation exhaust system; (3) the submittal adequately described the HLW basemat and embedded portion of the C5 area ventilation exhaust system as SDC SSCs; and (4) the submittal adequately addressed the six essential documentation elements for the basemat and the embedded portion of the C5 ventilation exhaust system.

4.2.4 HLW Facility TSRs

No TSRs were identified for the HLW facility basemat. Additional information on TSRs for the full HLW facility will be submitted with BNI's HLW PSAR.

4.3 Pretreatment Facility

The PT facility is not part of this SER. Information on the PT facility will be submitted with BNI's PT PSAR.

4.4 Balance of Facility

The BOF is not part of this SER. Information on the BOF will be submitted in four separate submittals, the first one being with the HLW PSAR.

4.5 Analytical Laboratory

The Analytical Laboratory is not part of this SER. Information on the Analytical Laboratory will be submitted with BNI's Analytical Laboratory PSAR.

5.0 EVALUATION – CAR CONTRACT DELIVERABLES

The following 11 documents are Contract requirements for BNI construction authorization:

- Construction Occurrence Reporting Plan (Final)
- Operating Authorization Plan Outline
- Emergency Response Plan (Draft)
- Conduct of Operations Plan (Draft)
- Training and Qualification Plan (Draft)
- Maintenance Implementation Plan (Draft)

- Occurrence Reporting Plan (Draft)
- Deactivation Plan (Draft)
- Environmental Radiological Protection Program (Draft)
- Technical Safety Requirements (Draft)
- Plan for Operational Assessment Reports (Draft)

The 11 documents were submitted to the OSR on January 25, 2002,[86] and are currently under review by the OSR. The review of these submittals is not part of this SER. However, two of the areas apply to the PCAR activities and are currently covered by two similar documents approved for Limited Construction. A Construction Occurrence Reporting Plan for Limited Construction[87] was submitted to the OSR with BNI's Limited Construction Authorization Request. The plan was accepted by the OSR[88] and is being used by BNI during limited construction. The plan uses the procedure 24590-WTP-GPP-SIND-001-0 to implement incident reporting and investigations. In response to Question LAW-PCAR-037 concerning whether this same procedure could be applied to partial construction, BNI responded that it could. The procedure was developed to address hazards and activities that would be expected to occur during the project's full construction phase. BNI re-evaluated the procedure for hazards and activities that would be associated with work performed during partial construction and determined that the work activities and hazards would be less severe than those associated with full construction. This response was acceptable to the reviewers. Subsequently, BNI committed to use the approved "Construction Occurrence Reporting Plan for Limited Construction" for the partial construction activities.[89]

In the area of emergency management, the OSR had previously determined[90] that BNI's 24590-WTP-GPP-SIND-019, *Emergency Management Program*, and 24590-WTP-GPP-SIND-003, *Emergency Action Plan*, were acceptable to support limited construction. BNI had trained emergency response organization staff and had implemented emergency response provisions sufficient to start construction. Subsequently, BNI committed that these two plans will continue to be in effect for partial construction and until the BNI draft Emergency Response Plan is approved.[91] This was acceptable to the reviewers.

[86] CCN: 026384, letter, A.R. Veirup, BNI, to M.K. Barrett, ORP, "Contract No. DE-AC27-01RV14136 – Contract Deliverables due with Construction Authorization Request for the Hanford Waste Treatment and Immobilization Plant," dated January 25, 2002.
[87] CCN: 021691, letter, A.R. Veirup, BNI, to M.K. Barrett, ORP, "Contract No. DE-AC27-01RV14136 – Supplement to Response to U.S. Department of Energy, Office of Safety Regulation Question 01-LCAR-001 on the Limited Construction Authorization Request," dated July 26, 2001.
[88] 01-OSR-0310, letter, R.C. Barr, OSR, to R.F. Naventi, BNI, "Contract No. DE-AC27-01RV14136 – Office of Safety Regulation Safety Evaluation Report of the Limited Construction Authorization Request," dated August 16, 2001.
[89] CCN: 034602, letter, A.R. Veirup, BNI, to M.K. Barrett, ORP, "Contract No. DE-AC27-01RV14136 – Response to Safety Evaluation Report Conditions for Acceptance Before Authorization for Construction of the Basemat for the High Level Waste and Low-Activity Waste Partial Construction Authorization Request," dated June 20, 2002.
[90] 01-OSR-0391, letter, R.C. Barr, OSR, to R.F. Naventi, BNI, "Contract No. DE-AC27-01RV14136 – Phase A, Limited Readiness Inspection Report, IR-01-004," dated October 23, 2001.
[91] CCN: 034602, letter, A.R. Veirup, BNI, to M.K. Barrett, ORP, "Contract No. DE-AC27-01RV14136 – Response to Safety Evaluation Report Conditions for Acceptance Before Authorization for Construction of the Basemat for the High Level Waste and Low-Activity Waste Partial Construction Authorization Request," dated June 20, 2002.

6.0 EVALUATION – CAR REQUIREMENTS

In addition to submittal of a Preliminary Safety Evaluation Report for construction authorization, BNI was required to submit additional documentation demonstrating that it was ready for construction.[92] Evaluation of the additional documentation is discussed in this section.

6.1 Contractor's Technical and Experience Qualifications to Construct the Plant

The purpose of this review was to determine whether the submittal adequately described the required technical and experience qualifications to construct the WTP.

6.1.1 Requirements

The requirements for technical and experience qualifications are found in Section 3.3.3 of DOE/RL-96-0003, which states, "A construction authorization will be issued by the ORP Manager (following review/concurrence from EM) based upon the determination and recommendation of the SRO that: 5. The Contractor is qualified by reason of experience and training to perform the proposed construction." In addition, the following review criteria were provided in Section F of the CAR review guidance document, RL/REG-99-05:

- "**Technical Qualifications** – BNI's technical qualifications reasonably ensured that the waste processing plant can be designed, built, and safely operated to accomplish the RPP-WTP mission. BNI described the relative technical experience of the team assembled to design and build the plant as well as the technical qualifications of the parent companies. This experience should include specific examples of directly related experience of the individuals (e.g., the project managers, area project managers, design managers, construction managers, operations managers, industrial safety managers, and environmental managers or their equivalent) in designing and constructing similar plants.

- **Experience Qualifications** – BNI's experience qualifications in constructing similar plants for processing nuclear waste reasonably ensured that the plant can be built and safely operated to accomplish the RPP-WTP mission. BNI described similar plants that have been constructed by the parent companies and the operating performance of the plants once completed."

6.1.2 Evaluation

BNI addressed its qualifications to construct the WTP in Attachment 10 of its PCAR submittal.[93] BNI cited the experience of Bechtel and of the Washington Group in constructing and operating

[92] DOE/RL-0003, Section 4.3, "Authorization for Construction."

the Defense Waste Processing Facility at the Savannah River Site and the West Valley Demonstration Project to treat HLW. The BNI Project Manager had direct experience at the Savannah River Site in constructing the facility. The BNI Operations Manager managed the Defense Waste Processing Facility and the tank farms at the Savannah River Site and also managed the West Valley Demonstration Project.

The BNI ES&H manager led the safety analysis program for the Defense Waste Processing Facility. The BNI environmental manager led environmental programs in the DOE complex at Fernald and at West Valley facilities and achieved DOE's Voluntary Protection Program Star status at West Valley. The BNI QA manager had considerable experience in nuclear QA management, startup, and operations. Overall, BNI had obtained considerable vitrification experience by selecting managers, engineers, and others from the two U.S. vitrification projects at Savannah River and at West Valley. BNI also had selected managers with considerable construction experience at DOE facilities. BNI further cited its experience in managing the environmental restoration program at the Hanford Site. Biographical information was provided on the key individuals.

6.1.3 Conclusions

Based on the information provided in Attachment 10 to the PCAR submittal, the OSR concluded that the Bechtel-Washington Group team met the technical and experience qualifications to construct the WTP.

6.2 Approach to Implement the Construction and Preoperational Portions of the SRD and ISMP

The purpose of this review was to determine whether BNI adequately described its approach to implementing the construction portions of the SRD and ISMP as they applied to construction of the basemats.

6.2.1 Requirements

The submittal on approach to implementing the construction portions of the SRD and the ISMP was acceptable if the following criteria were met:

1. The submittal or revisions to the SRD and ISMP clearly delineated which portions of the SRD and ISMP pertain to construction and pre-operational testing.

[93] CCN: 026767, letter, A.R. Veirup, BNI, to M.K. Barrett, ORP, "Contract No. DE-AC27-01RV14136 – Request for Review and Approval of the Partial Construction Authorization Request for the River Protection Project – Waste Treatment Plant," Attachment 10, "Contractor's Technical and Experience Qualifications to Construct the Plant." dated November 12, 2001.

2. An approach was described to ensure that the relevant portions of the SRD and ISMP are implemented.

3. The approach was consistent with the approaches described in the ISMP (i.e., Section 4.1, "Safety Management Processes") for ensuring that the SRD's safety criteria are implemented.

4. Consistent with the DOE/RL-96-0003 requirement, the approach described construction and pre-operational testing procedures that adequately ensure that the construction-related part of the SRD (e.g., the safety criteria identified in Table G.1 of this section) will be properly implemented. Alternatively, for construction or pre-operational testing procedures that are not developed before the CAR is submitted, sufficient descriptions were provided to ensure that the construction and pre-operational testing portions of the SRD and ISMP are implemented.

6.2.2 Evaluation

The description on the approach to implement the construction portions of the SRD and ISMP was provided in Attachment 6 of the PCAR transmittal letter.[94] In response to Question LAW-PCAR-009 concerning whether BNI had completed the process of identifying the applicable portions of the SRD and ISMP, as described in Step 2 of Attachment 6 of the LAW PCAR, BNI stated that they had and that the applicable citations to the SRD and ISMP were contained in the "requirements" subsection of each chapter of the PCAR. The applicable SRD and ISMP requirements were reviewed and approved as an integral part of the project-wide PCAR review and approval process.

The reviewers further questioned (Question LAW-PCAR-009) whether BNI had completed the identification and development of processes and procedures to implement the regulatory commitments, as described in Step 3 of Attachment 6. BNI responded that current management controls were in place for developing, reviewing, and approving plans, programs, and procedures to address conformance to the authorization basis, including the SRD and ISMP. Subsequently, the identification and confirmation of procedures to support specific PCAR construction activities were completed as part of a BNI self-assessment of its readiness to proceed with partial construction.[95] The OSR confirmed in Inspection Report IR-02-008, in preparation, that identification and confirmation of these procedures had been completed.

The reviewers questioned (Question LAW-PCAR-009) how the self-assessment and declaration of readiness activities described in Step 4 of Attachment 6 would be performed. BNI responded

[94] CCN: 024490, letter, A.R. Veirup, BNI, to M.K. Barrett, ORP, "Contract No. DE-AC27-01-RV14136 – Request for Review and Approval of the Partial Construction Authorization Request for the Hanford Tank Waste Treatment and Immobilization Plant," Attachment 6, "Approach to Implement the SRD and the ISMP," dated December 10, 2002.

[95] CCN: 034798, letter, A.R. Veirup, BNI, to W. J. Taylor, ORP, "Contract No. DE-AC27-01RV14136 –Declaration of Readiness for Partial Construction Authorization Activities," dated June 12, 2002.

that they would complete a self assessment, including an assessment of compliance with applicable portions of the SRD and ISMP, as part of its declaration of readiness to proceed with construction. The declaration of readiness will be a formal letter to DOE from BNI before commencing partial construction activities.

The OSR reviewed the submittal and the responses to Question LAW-PCAR-009 and determined that they were acceptable. The responses adequately addressed the first two acceptance criteria because their approach (1) delineated which portions of the SRD and ISMP pertained to construction, and (2) ensured that relevant portions of the SRD and ISMP will be implemented. The responses also adequately described the management process for ensuring that the SRD safety criteria will be implemented, and the approach was consistent with Section 4.1 of the ISMP, meeting acceptance Criterion 3. Finally, the plans for project management approved self assessments, along with a declaration of readiness to DOE adequately addressed acceptance Criterion 4 because the self assessments included an explicit review of conformance to applicable SRD and ISMP requirements.

6.2.3 Conclusion

The reviewers concluded that the approach to implementation of the construction and pre-operational portions of the SRD and ISMP during partial construction was acceptable.

6.3 SRD and ISMP Acceptability and Compliance

The purpose of this review was to determine whether BNI is compliant with the SRD and ISMP. Compliance was determined by integrating the results of the PCAR review with the results of OSR assessments of BNI as they relate to PCAR activities.

6.3.1 Requirements

The submittal on assessing compliance to the SRD and ISMP was acceptable if the following criteria were met:

1. The safety-related activities will be conducted according to the approved ISMP.

2. The design complied with the design-related portions of the SRD.

3. The proposed changes to the SRD and ISMP were acceptable.

4. The SRD complied with the requirement of the SRD, Section 3.6, "Maintenance of the SRD," and Section 4.0, "Confirmation Process."

5. Revisions to the SRD complied with the SRD, Appendix A, "Implementing Standard for Safety Standards and Requirements Identification."

6. The SRD and ISMP complied with the ISMP, Section 3.3.2, "Control of the Authorization Basis."

7. BNI adequately followed the procedure described in the SRD and ISMP for independent review and assessment of SRD changes. (Section 3.6, "Maintenance of the SRD")

6.3.2 Evaluation

The evaluation was performed by reviewing all PCAR submittal sections to determine if they complied with the approved SRD through Rev. 0d (March 6, 2002) and the ISMP through Rev. 1 (April 19, 2002). This included evaluating SRD Safety Criteria 1.0-9, 1.0-10, 2.0-1, 2.0-3, 3.2-1, 4.0-1, 4.1-1 through 4.1-5, 5.0-1, 5.1-2, 5.3-2, 5.3-3, 5.3-4, 5.3-5, 6.0-3, 7.0-4, 7.1-1, 7.1-2, 7.1-3, 7.3-1 through 7.3-12, 7.7-1 through 7.7-9, 7.8-1; 9.1-1, Appendices A and B of the SRD and Sections 1.3.2 through 1.3.18, 2.2, 2.3, 3.3, 3.5, 3.10, 3.15, 3.16.1 and 3.16.3 of the ISMP.

BNI identified PCAR activities that may impact ITS SSCs. These were limited to design and installation of the basemat and FRE. These activities were evaluated to ensure that their conduct was according to the approved SRD and ISMP. Details of these evaluations can be found in Sections 3.0 and 4.0 of this SER. No instances of noncompliance with the requirements of the SRD or ISMP were identified.

6.3.3 Conclusions

The compliance of proposed partial construction activities with the SRD and ISMP was found to be acceptable. The reviewers concluded that the Contractor's proposed activities would comply with the SRD through Rev. 0d and the ISMP through Rev. 1.

6.4 Revised Radiation Protection Program

A revised Radiation Protection Program is not required for the PCAR because the approved Radiation Protection Program includes construction activities in its scope.

6.5 Operating Authorization Request Outline

An Operating Authorization Request Outline is not required for the PCAR. It will be submitted with the LAW PSAR and evaluated before authorizing full construction of the LAW and HLW facilities.

6.6 Deactivation Safety Assessment Outline

An outline of the Deactivation Safety Assessment is not required for the PCAR. It will be submitted with the LAW PSAR and evaluated before authorizing full construction of the LAW and HLW facilities.

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6.7 Design Data and Design Drawings

The purpose of this review is to determine whether BNI submitted design data and design drawings in a timely manner to support the description of facility SSCs, including those designated as ITS.

6.7.1 Requirements

The requirements for design data and design drawings are found in Section 4.3.2 of DOE/RL-96-0003, which states, "The CAR submittal package shall consist of the following documentation: A PSAR containing the following: Design data and design drawings to support the description of facility structures, systems, and components including those designated as important to safety." In addition, the following review criteria were provided in RL/REG-99-05, Section M, "Design Data and Design Drawings":

1. "BNI submitted or made available promptly and conveniently, as necessary, the appropriate design data for the CAR reviewers. The design data may be controlled but must be readily accessible to reviewers either in a controlled facility provided by BNI or controlled by the OSR.

2. BNI submitted or made available, as necessary, the appropriate design drawings for the CAR reviewers. The design drawings may be controlled but should be readily accessible to the CAR reviewers either in a controlled facility provided by BNI or controlled by the OSR."

6.7.2 Evaluation

While some of the design data and design drawings were submitted to the OSR with the LAW and HLW PCAR submittals, much of the design data and calculations were not available until much later because, in most cases, the data and calculations had not been completed. For example, thermal analyses for the basemat and pour cave walls were not issued for OSR review until February 7, 2002, and BNI's analysis of the effects of a glass spill on the basemat was not issued for OSR review until March 27, 2002. BNI performed three related calculations for the glass spill onto the HLW basemat, with the last one not available for OSR review until April 11, 2002. Design data and calculations related to structural characteristics of the LAW and HLW basemat were not available until two months after the initial PCAR submittal. The review of preliminary calculations and drawings, which were revised frequently during the OSR review, required the reviewers to expend considerably more time to review the BNI requests for partial construction than was originally planned when the PCAR concept was accepted. While the reviewers were ultimately able to perform the detailed review of many parts of the BNI PCAR submittal, final review and evaluation of the structural characteristics were delayed, and the final review was not completed until the end of May 2002.

As of April 30, 2002, all requested design data and design drawings necessary for approval of the LAW and HLW basemats were provided.

6.7.3 Conclusions

The OSR obtained the design drawings and design data necessary to complete review of the basemats for the LAW and HLW facilities, which will be maintained as part of the review files. The reviewers expended extensive additional effort to complete the review on schedule because of the incomplete submittal and the slow delivery of sufficient information to resolve questions concerning the submittal. Future reviews can be expedited by earlier submittal of the applicable design drawings and design data with the CAR submittals.

7.0 RECOMMENDATIONS

7.1 LAW Facility

7.1.1 Basemat

Construction authorization shall be for the following specific activities related to the LAW facility basemat:

- Installing the FRE for the LAW basemat
- Installing the ground grid connections to LAW basemat rebar
- Placing the LAW basemat concrete
- Backfilling the LAW basemat.

Based on the detailed review performed by the OSR between December 19, 2001 and June 25, 2002, the OSR has concluded that the construction of the LAW facility basemat and other activities listed above, should be approved subject to the conditions of acceptance listed in Appendix B. Backfilling of the LAW basemat was not discussed in the LAW PCAR (Volume III). However, approval of backfill is authorized based on the approved process used for the limited construction authorization agreement.

7.2 HLW Facility

7.2.1 Basemat

Construction authorization shall be for the following specific activities related to the HLW facility basemat:

- Installing the FRE for the HLW basemat
- Installing the ground grid connections to HLW basemat rebar
- Placing the HLW basemat concrete
- Backfilling the HLW basemat.

Based on the detailed review performed by the OSR between December 19, 2001, and June 25, 2002, the OSR has concluded that the construction of the HLW facility basemat and other activities listed above, should be approved subject to the conditions of acceptance listed in Appendix B. Backfilling of the HLW basemat was not discussed in the HLW PCAR (Volume IV). However, approval of backfill is authorized based on the approved process used for the limited construction authorization agreement.

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9.0 LIST OF TERMS

AB	authorization basis
ACI	American Concrete Institute
AIChE	American Institute of Chemical Engineers
ALARA	as low as reasonably achievable

BNI	Bechtel National, Inc.
BOF	Balance of Facility
CAR	Construction Authorization Request
CFD	computational fluid dynamics
CM	configuration management
CSD	control strategy development
D&D	deactivation and decommissioning
DBE	design basis event
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
EIS	environmental impact statement
ERPP	Environmental Radiological Protection Program
ES&H	environment, safety, and health
FRE	forms, rebar, and embedments
FSAR	Final Safety Analysis Report
HLW	high-level waste
ISM	integrated safety management
ISMP	Integrated Safety Management Plan
ITS	important-to-safety
LAW	low-activity waste
NPH	natural phenomena hazard
NRC	U.S. Nuclear Regulatory Commission
ORP	Office of River Protection
OSR	Office of Safety Regulation
PC	performance category
PCA	Partial Construction Authorization
PCAR	Partial Construction Authorization Request
PSAR	Preliminary Safety Analysis Report
PT	Pretreatment
QA	quality assurance
QAM	Quality Assurance Manual
RCM	Radiological Control Manual
RCP	Radiological Control Program
RPP	River Protection Project
RWP	Radiation Work Permit
SC	seismic category
SDC	safety design class
SDS	safety design significant
SER	safety evaluation report
SIPD	Standards Identification Process Database
SL	severity level
SRD	Safety Requirements Document
SSC	system, structure, and component
TSR	technical safety requirement
UBC	Uniform Building Code
WTP	Waste Treatment Plant

Appendix A – Review Team

Table A.1 summarizes the review team's composition and expertise for review of BNI's PCAR and PSAR submittals.

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Table A.1. Review Team Membership Education and Experience

Review Team Member	Education and Experience	Areas of Review: LAW	HLW	PT	BOF	Anal. Lab
Jim Adams	B.S., Nuclear Engineering, Texas A&M University. Over 30 years experience related to nuclear operations and oversight of nuclear operations. Qualified as an ANSI Level III Test Engineer and a Senior Reactor Operator. Expertise in conduct of operations.	X	X			
Jay Boudreau	Ph. D., Engineering, University of California at Los Angeles. Over 30 years experience in nuclear reactor design, safety, fuel cycle technology and economics, waste management, and mission and systems analysis for NASA and the U.S. Department of Defense (DOD) nuclear power applications (terrestrial and space). Instrumental in helping the OSR establish and implement the WTP regulatory program.	X	X			
Ko Chen	B.S., Chemical Engineering, National Taiwan University; Ph.D., Mechanical Engineering, University of California Berkeley. Licensed mechanical engineer. More than 20 years experience in nuclear safety, fluid mechanics, mass transfer, and heat transfer.	X	X			
Tony Chung	B.S.M.E., Taiwan Chung-Hsing University, M.S.M.E., Washington State University. Licensed structural engineer. Over 25 years engineering experience, including over 17 years in structural and thermal analysis.	X	X			
Dick Cooper	B.S. Marine Engineering, U.S. Naval Academy, Masters Program (non-degreed), Radiation Health Physics, Georgetown University. QA lead auditor certification through Consolidated Edison. Over 30 years experience in nuclear power, including constructing, designing, operating, regulating, and providing safety oversight. Over 13 years with the NRC.	X	X			
James Cunnane	Ph.D., Nuclear Radiochemistry, Purdue University. Over 20 years experience in radioactive waste processing, evaluation of waste forms, vitrification of radioactive wastes, and radiochemistry.	X	X			
Dean Davis	B.S., University of Montana. Certified professional engineer in fire protection. Over 45 years experience in fire protection, including 14 years with DOE Richland Operations, and 15 years as Chief, Fire Protection, U.S. Army, Europe.	X	X			
Bob Defayette	B.A., Chemistry, St. Ambrose College; M.S., Physical Chemistry, Iowa State University. Over 35 years experience in the nuclear field with the NRC, DOE, and nuclear utilities. Extensive experience in assessing operational performance, QA programs, employee safety concerns, corrective action programs, and emergency preparedness.	X	X			
Richard Evans	B.A., Mathematics, Pomona College; B.S., Air Conditioning and Refrigeration, California Polytechnic Institute. Licensed professional engineer. Over 40 years experience in HVAC design and engineering, control systems, and mechanical systems.		X			

Review Team Member	Education and Experience	Areas of Review LAW	HLW	PT	BOF	Anal. Lab
Vic Ferrarini	B.S.M.E., University of Massachusetts at Dartmouth; M.S.M.E., University of Rhode Island. Registered professional engineer. Over 30 years experience in designing, analyzing, inspecting and auditing piping, pipe supports, pressure vessels, valves, pumps, and other mechanical components, including heat transfer and fatigue analysis of ASME (American Society of Mechanical Engineers) Class I components.	X	X			
Rick Garrison	B.S., Electrical Engineering, Washington State University. More than 17 years experience in systems engineering, design, installation, startup, operations, and maintenance of instrumentation, control, power, and data management systems at DOD and DOE facilities.		X			
Rob Gilbert	B.S., Metallurgical Engineering, University of Washington. Five years nuclear Navy and 10 years experience in waste vitrification technology and design, Hanford tank waste storage and treatment system design, and pressure vessel steel material performance.	X	X			
Robert Griffith	B.S., Mechanical Engineering, University of Arizona; M.S., Mechanical Engineering, Stanford University. Registered professional engineer. More than 26 years experience in systems engineering, licensing support, safety engineering, and environmental qualification at DOE, commercial power plants, and the Savannah River Site.		X			
Ann Hansen	B.S., Mathematics and Physics, Florida Southern College; M.S., Physics, Virginia Polytechnic Institute; M.S., Nuclear Engineering, Carnegie Mellon University. Over 25 years experience in hazard and accident analyses, safety analysis report development, and technical safety requirement development and analysis.	X	X			
Al Hawkins	B.S., Chemical Engineering, University of Washington; MBA, Operations Research, Washington State University. Project Management Official. More than 30 years experience in operations, oversight, safety, and QA. Former manager of Compliance Assurance and Director of Environment, Safety, Health and Quality Assurance.	X	X			
Quazi Hossain	B.S., Civil Engineering, Bangladesh University of Engineering & Technology; M.S., Structural Engineering, Texas A&M University; Ph.D., Structural Engineering, University of California, Davis. Licensed civil engineer. Fellow, American Society of Civil Engineers. Over 35 years experience in structural and seismic engineering, safety system classification, and safety design and analysis.	X	X			
Neal Hunemuller	B.S., Nuclear Engineering, Iowa State University. Certified NRC Operator Licensing Examiner; Licensed NRC senior operator; NRC-certified incident investigation team member. More than 20 years experience in commercial nuclear power and the NRC. Expertise in standards identification process, conformance/compliance reviews, and training and qualifications.	X				
Ninu Kaushal	B.A., B.S., and M.S. in Physics, Punjab University; MBA, Northern Illinois University; Ph.D., Nuclear Physics, Rensselaer Polytechnic Institute. More than 20 years experience in the commercial nuclear industry in nuclear physics, nuclear safety evaluations, nuclear criticality, electrical design, and instrument and controls; 10 years experience in nuclear research applying state-of-the-art instrumentation techniques.	X				

Review Team Member	Education and Experience	Areas of Review				
		LAW	HLW	PT	BOF	Anal. Lab
Bill Kennedy	B.S., Nuclear Engineering, Kansas State University; M.S., Nuclear Engineering, Kansas State University. Over 25 years experience in environmental and health physics. Nationally and internationally recognized expert in environmental radiological controls, environmental assessment, environmental regulations, radiation dosimetry, environmental pathway analysis, safety assessment and risk analysis, radiation shielding, health physics, and statistical analysis.	X	X			
Ron Lerch	B.A., Chemistry, Pacific Lutheran University; Ph.D., Inorganic Chemistry, Oregon State University. More than 30 years experience in nuclear waste management, nuclear technology development, nuclear fuel reprocessing, environmental cleanup, and project management; 2 years as Deputy Manager of Hanford tank farms.	X	X			
Barclay Lew	B.A., Mathematics, and B.S., Nuclear Engineering, University of California, Santa Barbara; M.S., Engineering; Ph.D., Nuclear Engineering, UCLA. Over 28 years experience in nuclear safety analysis, heat transfer, mass transfer and fluid flow, computational fluid dynamics, and analysis of safety analysis reports.	X	X			
Ron Light	B.A., Mathematics, and M.B.A., University of South Dakota. Over 30 years of experience in management systems, business management, program controls, and financial management. Regulatory process administrator in OSR.	X				
Chung-King Liu	B.S., Zoology, Fu-Jen Catholic University (Taiwan); M.S., Chemistry, Kansas State College - Pittsburgh; Ph.D., Nuclear Radiochemistry, University of Arkansas. NQA-1 lead nuclear auditor. Over 23 years experience in nuclear waste management, radiochemistry laboratory management, and environmental cleanup. Expertise in the areas of chemical process safety, nuclear process safety, and health physics.	X	X			
Surya Maruvada	Master of Engineering, Electrical Power Engineering/Indian Institute of Science. Licensed professional engineer. Over 30 years experience in nuclear safety and hazard analyses; probabilistic risk assessment; reliability, availability, maintainability (RAM) analyses; and electrical power and control systems.	X	X			
Steve Merwin	B.S., Environmental Engineering, Northwestern University; M.S., Health Physics, Colorado State University. Certified health physicist and certified industrial hygienist. Over 15 years experience in health physics, risk assessment, and accident analysis.	X	X			
Ellen Messer-Wright	B.S., Electrical Engineering, University of New Mexico; M.S., Environmental Science, Washington State University. Certified health physicist. Over 10 years experience in occupational radiation protection, ALARA, and radiological compliance assessments.	X	X			
Milon Meyer	B.S., Mechanical Engineering, University of Iowa. Over 35 years experience in structural analysis, equipment qualification, and finite element analysis related to nuclear, gas turbine, rockets, and aerospace.	X	X			

Review Team Member	Education and Experience	Areas of Review				
		LAW	HLW	PT	BOF	Anal. Lab
Lew Miller	B.S., Physics, Massachusetts Institute of Technology; M.S., Nuclear Engineering Science, University of California, Berkeley. OSR Safety and Standards Review Official. Certified license examiner, senior resident inspector. More than 25 years experience with the nuclear Navy and the NRC. Expertise in nuclear safety oversight, safety analysis reviews assessments, and incident investigations.	X	X			
Matt Moeller	A.B., Mathematics, Cornell University; M.S., Environmental Health Physics, Harvard University. Certified health physicist. Over 20 years experience in health physics, radiation protection, industrial safety and hygiene, risk assessment, and emergency preparedness.	X	X			
Joe Panchison	B.S., Mechanical Engineering, Drexel University. Licensed professional engineer. Over 23 years experience in mechanical engineering design, thermal hydraulic analysis, fluid systems analysis, HVAC, power piping, and nuclear component codes and standards. Direct experience in plant modifications and configuration management.		X			
Keith Parkinson	B.S., Electrical Engineering, Purdue University. Certified reactor operator. Over 35 years experience in the nuclear field, including 24 years in the nuclear Navy and 10 years as an NRC inspector and NRC operator license examiner. Expertise in training, fire protection, operations, and electrical distribution systems.	X	X			
Michael Plunkett	B.S.M.E., Mechanical Engineering, University of New Haven; M.S.M.E., Mechanical Engineering, University of Rhode Island. Licensed professional engineer. Over 29 years experience in designing, analyzing, inspecting, and auditing piping, pipe supports and other mechanical components in the power industry, fire protection, and NRC audits.	X	X			
Jeanie Polehn	B.S., Nuclear Engineering Technology, Oregon State University; M.S., Health Physics, Georgia Institute of Technology. Certified health physicist. Registered Environmental Manager. More than 20 years experience in radiation protection including occupational, environmental, and emergency response at commercial power plants and with DOE.	X	X			
Gerald Ritter	B.A., Chemistry, Pacific Lutheran University; B.S., Chemical Engineering, University of Washington; M.S., Chemical Engineering, University of California, Berkeley. Over 33 years experience in nuclear fuel fabrication and processing, nuclear waste management, and preparation and evaluation of safety analysis reports		X			
Grant Ryan	B.S., Physics, Frostburg State University; B.S., Nuclear Engineering, University of Maryland. Licensed professional engineer. Over 11 years experience in probabilistic risk analysis, radiological and toxicological consequence analysis, hazard analysis, and control selection methodologies.	X	X			
Ken Scown	B.S., Management Science, California State University, Hayward. Over 18 years nuclear fire protection auditing and consulting, including inspections for fire protection, emergency planning, and security. Worked 7 years fighting fires, servicing equipment, and training fire fighters; worked 6 years as a health and safety technician.	X	X			

Review Team Member	Education and Experience	Areas of Review				
		LAW	HLW	PT	BOF	Anal. Lab
Vern Severud	B.S., Civil Engineering, California State University-Chico; M.S., Civil Engineering, University of Arizona. Licensed professional engineer. Fellow of American Society of Mechanical Engineers. Over 40 years experience in seismic design and analysis, and elevated temperature design and analysis.	X	X			
Michael Shlyamberg	B.S.M.E., Polytechnic Institute, Lvov, USSR. Registered professional engineer. Over 20 years experience in design of nuclear safety support systems, thermal hydraulic calculations, safety evaluations, containment analysis, and preparation of safety analysis reports. Participant in over 45 NRC inspections and utility assessments.		X			
Bob Smoter	U.S. Navy Nuclear Power School. Over 20 years experience in commercial and DOE nuclear regulatory development, safety analysis reports, licensing, project management, and nuclear plant operations and maintenance.	X	X			
Robin Sullivan	B.S., Mechanical Engineering, University of Washington. Over 10 years experience in hazard analysis, risk assessment, safety licensing review, authorization basis development and maintenance, and regulatory compliance reviews.		X			
Mark Summers	B.S., Civil Engineering, Walla Walla College; M.S., Civil Engineering, Oklahoma State University. Over 21 years experience in structural engineering on various U.S. Army Corp of Engineer projects.	X	X			
Cindy Taylor	B.A., Business Management, Eckerd College; M.B.A., Engineering Management and Technology, City University. ANSI/ASME NQA-1 lead auditor. Over 13 years experience in QA program development and project management. QA support to DOE, NRC, OCRWM, and DOD-regulated projects.	X	X			
Kelly Thomas	B.S., M.S., and Ph.D., Nuclear Engineering, Texas A&M University. Over 10 years experience in the safety analysis area with emphasis on development of phenomenological models to support consequence assessments. Direct experience in modeling combustible gas transport and mixing in waste tanks and process vessels, and the development of analytical models for various gas-phase flammability and explosion phenomena.		X			
Susan Thraen	B.S., Nuclear Engineering, Pennsylvania State University. Over 17 years experience, including 6 with the NRC in regulatory process, nuclear facility design, construction, and operations. Expertise in safety analysis, radiation protection, emergency preparedness, regulatory compliance, and conduct of operations.	X	X			
Russ Treat	B.S., Chemical Engineering, Washington State University. Over 30 years experience in chemical and process engineering including nuclear waste management, processing of nuclear waste, and development of waste vitrification processes.	X	X			
James Troske	B.S., Electrical Engineering, Gonzaga University; M.S., Electrical Engineering, Montana State University. Licensed professional engineer. Over 30 years experience in electrical and control system engineering.		X			

Review Team Member	Education and Experience	Areas of Review				
		LAW	**HLW**	**PT**	**BOF**	**Anal. Lab**
Brian Vonderfecht	Ph. D., Nuclear Physics, Washington University. Over 11 years nuclear experience in the areas of nuclear criticality safety, accident analysis, probabilistic risk analysis, radiation shielding, and nuclear physics. Expertise in thermal-hydraulics, heat-transfer, diffusion, and chemical or thermal explosions.	X	X			
Bob Winkel	B.S. and M.S., Civil Engineering, Brigham Young University; Ph.D., Structural Engineering, University of Colorado. Registered professional engineer. Over 31 years experience in structural analysis and evaluation of nuclear structures and equipment using American Society of Mechanical Engineers, American Institute for Steel Construction, and ACI engineering design codes.	X	X			
Joe Yedidia	B.S., Mechanical Engineering, Israel Institute of Technology; M.S., Nuclear Science, Israel Institute of Technology; MBA, University of Pittsburgh. Over 30 years experience in spent fuel systems, reactor utility requirements, liquid metal reactor development, and mechanical and fluid reactor systems.	X				
Greg Yuhas	B.A., Management, St Mary's of California. National Registry of Radiation Protection Technologists. Over 24 years experience in radiation safety, including 17 years with the NRC and 3 years with DOE. Expertise in occupational radiation safety, effluent and environmental monitoring, and decommissioning.	X	X			

Appendix B – Conditions of Acceptance

The conditions of acceptance for the general information evaluation and for the facility specific evaluations are shown below by the section in which they were cited.

Section 3.7 Radiation Protection

Conditions of Acceptance – BNI must include the following provisions in the Radiological Controls Program. Except for Item 2 below, these provisions must be provided with the Final Safety Analysis Report (FSAR):

1. A detailed organizational chart that shows the radiation safety organization and its relationship to senior plant personnel and other line managers. Also, provide job descriptions defining specific authorities and responsibilities of radiation safety personnel.

2. Specify the review and revision cycle of procedures and provide to DOE before the start of the pre-operational testing phase.

3. Describe the mechanism for ensuring that RWPs are not used past their termination dates.

4. Describe the methods for analyzing airborne concentrations; methods for calibrating air sampling and counting equipment; actions levels and alarm setpoints; the basis used to determine action levels, investigation levels, and derived air concentrations and minimum detectable activities for the radionuclides; the frequency and methods for analyzing airborne concentrations; counting techniques; specific calculations and levels; action levels and investigation levels; locations of continuous air monitors, if used; and locations of annunciators and alarms.

5. Identify the types and quantities of contamination monitoring equipment and the methods and types of instruments used in the radiation surveys.

6. Identify the locations of the facility's respiratory equipment.

7. Describe the radiation measurement selection criteria for performing radiation and contamination surveys, sampling airborne radioactivity, monitoring area radiation, and performing radioactive analyses. List the types and quantities of instruments that are available, as well as their ranges, counting mode, sensitivity, alarm setpoints, and planned use. Describe the instrument storage, calibration, and maintenance facilities and laboratory facilities used for radiological analyses in the FSAR.

Section 3.12 Procedures and Training

Conditions of Acceptance – BNI must complete the following changes to Section 12.3 of Volume I of the PCAR with the first revision of the PSAR after authorization for construction:

1. Revise Section 12.3.1.1 to state that, "The project readiness assessment process determines the procedure set required to support Construction activities. Procedures are developed and issued before the activity governed by the procedure takes place." In addition, provide a table in Section 12.3.1.1 to indicate which activities are being addressed in management control procedures during design and construction, cold commissioning, and hot commissioning and operations.

2. Revise Section 12.3.2.2 to state, "The procedures covering the following topics are in place as needed for the construction phase of the project. Changes and additions to the procedure set will be identified before cold commissioning and scheduled for completion before the activity taking place: major management control systems, system and facility operations (including control of hazardous processes), major maintenance activities (including safe work practices), hazardous materials control activities, radiological control activities, and emergency response activities (including radiological and hazardous chemical release)."

3. Revise Section 12.3.1.1 as follows to clarify who can approve procedures: "The procedure process is governed by the project procedure on procedures. It requires that management associated with ES&H and QA review new procedures and concur that they are or are not within the authorization basis. ES&H and QA review changes to existing procedures if they affect the authorization basis or QA requirements. At a minimum, management associated with the relevant safety disciplines concurs with new procedures and changes to existing procedures that affect the authorization basis requirements."

4. Add the following to Sections 12.3.3.1 and 12.3.3.2.1: "The project procedure complies with the WTP QAM and addresses permanent procedure revisions and expedited procedure changes."

5. Add the following to Section 12.3.1.1: "For construction activities, the basic work planning process is based on the concept that for standard construction tasks, step-by-step work instructions are not required. A combination of technical specifications, field procedures, and drawings are used to perform the work. Individuals involved in the work are trained to the requirements. The work is planned using a construction administrative procedure addressing construction work packages. When unique or complex tasks are performed, work planning is addressed in a construction administrative procedure addressing special instruction work packages. This procedure provides for using a work package with additional controls, including, where appropriate, step-by-step instructions."

Conditions of Acceptance – BNI must complete the following changes to Section 12.4 of Volume I of the PCAR with the first revision of the PSAR after authorization for construction:

1. Define the periodic basis for comparing training materials with the list of tasks selected for training.

2. Clearly state in the learning objectives the knowledge, skills, and abilities the trainee must demonstrate; that learning objectives are sequenced based on their relationship to one another; the conditions under which required actions will take place; and the standards of performance the trainee should achieve when completing the training.

3. Define review and approval requirements for lesson plans, training guides, and other training materials before they are issued and used.

4. Describe that when an actual task cannot be performed and is walked-through, the conditions of task performance, references, tools, and equipment reflect the actual task to the extent possible.

5. Define the periodic basis for conducting training program evaluations.

Section 3.16 Deactivation and Decommissioning

Conditions of Acceptance – BNI must complete the following changes to Chapter 16 of Volume I of the PCAR, or to the draft deactivation plan, with the first revision of the PSAR after authorization for construction:

1. In Chapter 16 or in the draft deactivation plan, clarify its commitment to reduce radiation exposure to workers and the public during and following D&D.

2. Add the following statement to Section 16.3.5: "While the proposed decommissioning method has not been specified, the facility is being designed to limit contamination, facilitate decontamination, and minimize the dose and generation of waste in the event reuse or demolition of the facility is the ultimate decommissioning method."

3. Change the R1, R2, and R3 contamination classifications listed in Section 16.3.1 consistent with current practices, i.e., C1, C2, C3, and C5 classifications.

Section 3.17 Management, Organization, and Institutional Safety Provisions

Conditions of Acceptance – BNI must complete the following actions by the date or milestone indicated:

1. Describe organizational responsibilities and staffing interfaces for the configuration management program in Section 17.4.3 of Volume I of the PCAR with the first revision of the PSAR after authorization for construction.

2. Revise procedure 24590-WTP-GPP-SIND-001-0, *Reporting Occurrences in Accordance with DOE Order 232.1A,* to address hazards and activities before the start of pre-operational testing phase.

Section 4.1.2 LAW Facility Hazard and Accident Analysis

Conditions of Acceptance – BNI must complete the following actions by the date or milestone indicated:

1. Correct the discrepancies related to the CSD records identification system used in SIPD and as referenced in the LAW PCAR and HLW PCAR texts and tables with the first revision of the PSAR after authorization for construction.

2. Revise the design calculation report 24590-LAW-DBC-S13T-00005, *Thermal Analysis for Basemat and Pour Cave Walls*, to incorporate the results of the computational fluid dynamics analysis of the pour cave. The analysis must confirm that the concrete temperatures of the melter and pour caves could be maintained within design limits during the postulated loss of cooling accident scenario. All structural calculations affected by the computational fluid dynamics analysis must be revised, as appropriate. These should be completed before authorization of LAW facility construction.

3. Revise the PSAR to correct the omission of an additional safety function for the basemat based on the seismic DBE event being SL-2 for the facility and co-located worker, the mis-feed event being SL-1 for the facility worker, and the liquid spill/overflow from the LAW concentrate receipt vessel being SL-2 for the facility worker. This revision must be done with the first revision of the PSAR after authorization for construction.

4.2.1 HLW Facility Description

Process Description

Conditions of Acceptance – BNI must complete the following action by the date or milestone indicated:

1. Revise the design drawings that were used to support the hazard and accident analysis of the embedded C5 ventilation ductwork to reflect the configuration used in the accident analysis with the first revision of the PSAR after authorization for construction.

2. Perform transient computational fluid dynamics analysis of the design basis event 2700 L HLW molten glass spill before authorization of HLW facility construction.

Section 4.2.2 HLW Facility Hazard and Accident Analysis

Conditions of Acceptance – BNI must complete the following actions and provide to DOE before authorization by the date or milestone indicated:

1. Provide the DBE analysis of the 2700 L HLW molten glass spill accident before authorization of HLW facility construction.

2. Submit an evaluation of the combined effects of seismically induced radiological releases from the PT, LAW, and HLW buildings on the workers, co-located workers, and the public through a seismic PRA study, before authorization of full facility construction (not including the Analytical Laboratory).

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